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ABSTRACT

This practicum addresses the need to organize a structured problem solving program for fifth and seventh grade students. The improvement of the students' problem solving skills and the enhancement of students' attitudes toward problem solving in mathematics were the main goals. The program implemented consisted of a structured problem solving regimen involving students in a variety of guided activities, as well as independent and cooperative group learning. Students were exposed to various strategy techniques and offered opportunities for application of the different strategies. The use of calculators was emphasized. Included in this study are: (1) "Introduction"; (2) "Study of the Problem"; (3) "Anticipated Outcomes and Evaluation Instruments"; (4) "Solution Strategy"; and (5) "Results, Conclusions and Recommendation". Appended are a copy of the attitude survey related to problem solving, parental support letter, attendance certificate, and the results of the pretest attitude survey. (KR)

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Improving Mathematical Problem Solving Skills
of Fifth and Seventh Grade Students Through
a Structured Problem Solving Program

by

Deborah A. Hawver

Cluster 29

A Practicum II Report presented to the
Ed.D. Program in Early and Middle Childhood
In Partial Fulfillment of the Requirements
For the Degree of Doctor of Education

Nova University

1990

PRACTICUM APPROVAL SHEET

This practicum took place as described.

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This practicum report was submitted by Deborah A. Hawver under the direction of the adviser listed below. It was submitted to the Ed.D. Program in Early and Middle Childhood and approved in partial fulfillment of the requirements for the degree of Doctor of Education at Nova University.

Approved:

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CHAPTER I

INTRODUCTION

Description of Work Setting and Community

The writer's work environment reflected that of a small town public elementary school consisting of kindergarten through seventh grade. It maintained a faculty and staff of about 37 members which is supported by twenty regular classroom teachers, two in special education, five members in the Chapter I and/or remedial programs with one aide. There was one physical education teacher and one speech teacher, a school librarian who had an aide, and four additional aides who were utilized in grades kindergarten through the third grade. Grades fourth through the seventh were without aide assistance. The school was under the administration of five local board members, a superintendent, and a principal. Also, the school had two secretaries, a guidance counselor, and a Chapter I coordinator.

Many of the teachers held a master's degree in early or middle grades education. Four members possessed a specialist degree in the same field. The superintendent received his specialist degree in administration in 1984. An estimated 20 out of 37 members of the teaching staff commuted daily to work from a larger neighboring town

15 miles away. A few, however, traveled from other surrounding areas.

The student population ranged from 420 to 430 students during the school term. The student body consisted of about 63% white and 35% black. During the fall, 10 or 15 Mexican American migrant students attended the school.

The curriculum in general is very basic with respect to subjects offered. They included reading, mathematics, English, social studies, science and health. Physical education, speech, special education, and a gifted class were other programs that were provided. The music and art programs were the sole responsibility of each classroom teacher. In addition, 4-H once a month contributed to the curriculum for grades fifth through seventh.

The community in which the school is located contained approximately 3,400 people, according to a 1984 census, of which about 1,684 lived within the city limits. From the total figure nearly 2,150 of the population were white and 1,250 were black. Farming was one of the primary occupations of its residents. There were also several small factories and mobile home industries which supplied many local jobs. The area's employment level as recorded in 1986, stated that out of the 1,608 which make up the workforce, 1,494 were working, whereas 114 were unemployed. In addition, the socioeconomic situation probably ranked average, if not a little above average.

Writer's Background, Work Setting, and Role

In reference to the writer's background, it should be expressed that the writer had fifteen years of teaching experience. Beginning in a rural school in 1975, two years were spent teaching in the special education program with a B.S. degree in Behavioral Science. In 1977, a master's degree in elementary education was received. Thus, a move was established toward the regular classroom. The writer remained in the same setting for one year as a sixth grade teacher, and one year serving as a Chapter I instructor in mathematics for grades first through third. The next teaching opportunity was in another state in which the setting consisted of a low economic, predominantly black public school population. There the writer was employed two years as a teacher of the fifth grade.

In the practicum setting the writer had devoted the last nine years of teaching. Two years have been spent in a sixth grade position and seven in the fifth. The writer was one of many teachers who commuted from a fifteen mile distance. In 1983, a specialist degree in middle grades education was earned. The writer occupied a fifth grade position during the time of this practicum which included the teaching duties of the basic core curriculum with an emphasis in mathematics. The writer especially enjoyed teaching mathematics and had always been concerned with children's development of mathematical skills. In addition, the writer served as the Chapte. I coordinator of reading and mathematics for the elementary school system. The responsibilities of conducting music and art activities also had to be maintained. Another obligation was serving on the hospitality committee which organized specific school functions. As an annual event the writer had been in charge of organizing field day activities. This duty had been quite rewarding due to the writer's strong interest in the physical fitness of the children. Since the school system had presently hired a physical education teacher, this responsibility was altered.

CHAPTER II

STUDY OF THE PROBLEM

Problem Description

The problem which existed in the writer's work situation involved the low performance of problem solving skills in mathematics. Since the writer had been employed in this particular school system, the writer, as well as other teachers, basically employed the textbook method for teaching problem solving. Thus, the students were engaged mainly in drill of computational skills with little concentration directed toward problem solving. The activities for problem solving usually involved the students working four or five problems which are presented at the end of each daily lesson. These problems in most cases were structured in a manner which complied with the objectives for the lesson; therefore, the operation and computational skills tend to be the same. The textbook also contained about ten to fourteen problems at the end of each unit which were based on skills related to the unit.

Over a period of time the writer had observed the low mathematics achievement levels of many fifth and seventh grade students. In particular the writer was concerned with the component of problem solving. This was a key area in which students tended to perform poorly. In connection with an inadequate ability to solve word problems, students experienced difficulties in coping with everyday life situations and in developing positive attitudes toward problem solving. These factors served as evidence that the students were affected as a result of insufficient problem solving skills. Teachers and parents were indirectly affected when assisting students to reach their full potential in mathematics, as well as in other areas of the curriculum. Furthermore, society was ultimately affected when children, who are to soon become adults, can not apply problem solving strategies to common daily life encounters.

The problem had not been solved mainly because the educational attention had not been focused on the development of students' problem solving skills to the extent needed. Students were not receiving the proper guidance in order to acquire the techniques necessary to solve problems. The approach used to teach problem solving did not consist of an environment which fostered thinking.

In summary, the problem was that the fifth and seventh grade students did not have adequate problem solving skills.

Problem Documentation

Pretest percentile scores for the problem solving component of the Iowa Test of Basic Skills (ITBS) served as documentation of the problem. The Iowa Test of Basic Skills manual indicated that the 50th percentile showed the national average performance. Grade-equivalents gained from raw scores were converted to percentile ranks in grades, stanines, and normal curve equivalents (Hieronymus, Hoover, & Lindquist, 1986).

The pretest normal curve equivalents (NCEs) and percentile scores for this practicum are recorded by grades and classes. Pretest scores are listed on Table I for Grade 5, Class A, and Table 2 for Grade 5, Class B. Table 3 indicates scores for Grade 7, Class C. The tables will also show information concerning students' age and sex.

The scores illustrated on Table I for Class A of fifth graders show that 7 out of 33 students scored below the 50th percentile. Class A represents the upper group of fifth grade students. Scores for Class B of fifth graders, which is a lower level group, indicate a larger number of students scoring below the 50th percentile with 18 out of 19. Class C. of seventh grade students, which is an upper level group, tended to score higher with only 6 out of 22 exhibiting a score below the 50th percentile.

According to Wilderman and Sharkey (1980), a national assessment of achievement by the National Institute of Education found in the early 1980s a decline in mathematical performance. There was a 1% decrease for nine

Table 1

Pretest Normal Curve Equivalents and Percentiles - April, 1989 - Grade 5 - Class A

Student Number	Age	Sex	NCEs	Percentiles
1	10	F	57	63
2	11	F	44	39
3	10	F	99	99
4	10	M	63	72
5	9	M	74	87
6	10	F	64	75
7	11	M	57	63
8	10	F	47	45
9	10	F	80	93
10	10	M	64	75
11	10	M	56	62
12	10	M	33	21
13	10	M	64	75
14	10	F	56	61
15	10	F	44	39
16	10	F	94	98
17	10	F	44	39
18	10	M	70	83

(table continues)

Student Number	Age	Sex	NCEs	Percentiles
19	10	F	80	93
20	10	M	63	72
21	10	F	64	75
22	10	F	87	96
23	10	F	87	96
24	10	M	56	6[illegible]
25	10	M	51	51
26	10	F	56	61
27	11	F	33	21
28	10	F	64	75
29	10	F	74	87
30	10	F	33	21
31	10	F	56	61
32	10	F	59	67
33	12	M	66	78

Table 2

Pretest Normal Curve Equivalents and Percentiles - April, 1989 - Grade 5 - Class B

Student Number	Age	Sex	NCEs	Percentiles
1	11	F	44	39
2	11	F	41	33
3	11	M	20	8
4	11	M	43	36
5	10	F	44	39
6	11	M	43	36
7	11	M	56	61
8	10	M	37	26
9	11	F	33	21
10	11	F	33	21
11	11	F	29	16
12	11	M	44	39
13	12	F	43	36
14	11	M	45	40
15	12	M	47	45
16	10	M	43	36
17	12	F	20	8
18	12	F	37	26
19	10	M	47	45

Table 3

Pretest Normal Curve Equivalents and Percentiles - April, 1989 - Grade 7 - Class C

Student Number	Age	Sex	NCEs	Percentiles
1	12	M	76	89
2	13	M	54	58
3	12	M	38	28
4	11	F	41	33
5	12	M	46	42
6	13	M	57	64
7	12	M	31	18
8	11	M	59	66
9	11	F	59	66
10	12	F	82	93
11	11	F	63	74
12	12	F	60	69
13	12	M	63	74
14	12	F	54	58
15	12	F	66	78
16	12	F	43	37
17	14	M	76	89
18	12	F	72	85

(table continues)

Student Number	Age	Sex	NCEs	Percentiles
19	11	F	66	78
20	12	M	66	78
21	12	F	48	46
22	11	F	60	69

year olds, 2% for thirteen year olds, and 4% for seventeen year olds. The major problem was not learning the computational skills, but being able to apply the skills. The ten basic skill areas in mathematics as identified by the National Council of Supervisors include problem solving, applying mathematics to everyday situations, alertness to reasonable mathematical results, estimation and approximation, computational skills, geometry, measurement, mathematical prediction, and computer literacy. A final area involved the reading, interpreting, and constructing of tables, charts, and graphs. Each of these competencies requires the understanding of mathematical concepts. These competencies require students to have the ability to think and critically analyze a problem which goes far beyond simple memorization. It is important that mathematics be taught in an enjoyable atmosphere and taught in such a way as to enhance thinking skills and problem solving.

LeBlanc (1982) stressed the recommendation made by the National Council of Supervisors of Mathematics which stated that the principle reason for studying mathematics is to learn to solve problems. According to the results of the 1978 National Assessment of Educational Progress in Mathematics, it was indicated that there was a decline in the most basic problem solving skills. Furthermore, the results specified a decline in performance on applications and problem solving by nine and thirteen year olds.

The "back to basics" movement placed emphasis on computational skill building through mastery learning. It was desired that this attempt would remedy students' lack of mathematical skills. Now, however, many mathematics educators are stressing the need for students to understand mathematical concepts. The emphasis is changing from content to processes of mathematics thinking. Students need to be encouraged to ask questions that can be answered. In order for students to ask and answer reasonable questions, they must be capable of arranging and analyzing information. Thus, systematic thinking is vital. In addition, The National Council of Teachers of Mathematics in An Agenda for Action: Recommendations for School Mathematics of the 1980s stated as its first recommendation that problem solving be the focus of school mathematics (Chisko, 1985).

Fennell and Ammon (1985) further expressed recommendations provided by the 1978 National Assessment of Educational Progress (NAEP), The National Council of Teachers of Mathematics in An Agenda for Action, and the Priorities in School Mathematics (PRISM) Project. All sources pointed toward greater emphasis on problem solving skills in elementary school mathematics.

In addition, Rosenbaum, Behounek, Brown, and Burcalow

(1989) indicated that problem solving has emerged as a central focus for school mathematics.

Causative Analysis

An analysis for the cause of low problem solving performance of the fifth and seventh grade students was directly related to the approach in which problem solving was taught. The approach for teaching mathematics had been based on the textbook method which had served as the major, if not only, source for instruction. The daily lessons concentrated on the introduction of new skills and concepts with explanations of computational processes. Practice activities at the board and at students' individual desk involved drill of computational skills which occupied a sizeable portion of the mathematics class period. A few word problems came at the end of each daily lesson which mainly served to review the same objectives. In addition, as a final lesson for each unit, ten to fourteen word problems were included.

Another cause factor which contributed to students' insufficient development of problem solving skills was the classroom environment. The class activities were structured in a routine fashion; whereby, students followed the guided format of the textbook. There was minimal opportunity for students to engage in creative problem solving experiences. In order to be creative, students must be motivated to think. Thus, the classroom atmosphere must be conducive to thinking.

An additional aspect concerned with the cause of the problem dealt with students' lack of participation in activities which enabled them to apply word problems in a variety of settings. Students were not being exposed to classroom arrangements which related to daily life situations. Students needed to develop an understanding of mathematics which could be connected to the real world. Many students in the writer's setting were not given these types of experiences whereby they could manipulate materials to gain an understanding of concepts and strategies required to solve problems in mathematics. Furthermore the teachers did not utilize calculators and computers as a part of their daily instruction.

Many students lacked positive attitudes toward working word problems due to some of the reasons discussed. In most cases students did not feel confident working word problems. Therefore, students usually responded to word problems by complaining and trying to create ways to get out of such assignments. It was evident that in order for improvement to take place, there had to be a change in the instructional approach to problem solving.

Relationship of the Problem to the Literature

Recognition of the importance of problem solving in mathematics has stimulated much research pertaining to the issue. Hawkins (1987) interviewed 132 mathematics teachers and realized that many use the easiest or least stressful approach to teach problem solving or skill application. It was determined from the interviews that a typical class period involves answering questions about a previous lesson, explaining the next topic by using examples with discussion, working exercises and discussing, and assigning homework. This sequence of events fosters mindless manipulation since mathematics requires students to apply mathematics to a variety of situations. Some basic principles were suggested in order for students to become good problem solvers. Mathematics must be taught in a manner capable of being interpreted. Mathematics must be taught in a developmental sequence depending on the students' experiences. A balance between the teaching of processes and of social application helps to encourage motivation. Success-oriented techniques should be employed to prevent emotional blocks. Problem solving must be included each day with mathematics skills and computations so its application will be understood. Learning of problem solving is stimulated through guided discovery. Creative problem solving should be encouraged. Practice in skill development should be provided when it has significance to the students. Evaluation should be a continuous process of both the teacher and the student.

Gilbert-Macmillian and Leitz (1986) emphasized that problem solving is often taught by the same methods used to teach basic computation. This method includes short lectures with a demonstration and plenty of individual seat work on practice problems. Children's thinking is limited by these methods because problem solving requires a higher-order of thinking. The approach to solving a word problem is less direct than simply applying an algorithm that leads to the solution. Students need to discover what information is relevant, plan a way to manipulate the appropriate information, carry out these manipulations, and evaluate the solution by looking back over the original problem statement.

DeVault (1981) concluded that doing mathematics is problem solving. It is like writing in the language arts, which requires competency in certain basic skills. Mathematical problems can not be solved without some knowledge of the basic facts or competency in computation, understanding of operations, and the ability to sequence task in a logical order. In today's elementary school mathematics curriculum, however, so much time is devoted to the practice of these skills that little time is left for using these tools for problem solving.

Problem solving is a process whereby an individual relies on previously learned material to cope with the requirements of a new situation. Solving word problems as a practice for algorithms introduced in a textbook lesson do not require higher-order thought processes. Due to the lack of confidence and ability of students to solve these simpler word problems, a new approach is necessary for students to acquire the appropriate skills needed for true problem solving (Havel, 1985).

Hill (1980) emphasized that as educators we should prepare students to approach nonroutine problem solving tasks. Students need to become comfortable with making choices. However in order for this to happen there needs to be a change in attitude and classroom environment. It was stated in An Agenda for Action (1.3) that "Mathematics teachers should create classroom environments in which problem solving can flourish." An open mind is the key to the development of problem solving ability. This would involve students in exploration, probing and making intelligent guesses. Problem solving is a creative activity which can not be developed through routines, recipes, and formulas.

Brandau (1985) investigated an elementary mathematics classroom, where the teacher taught children age 5 - 10 years old at a private school, by using field notes, audiotapes, and videotapes. The study was carried out for a one year period. The purpose of the study was to analyze the teacher's struggle to encourage thinking in mathematics. It was observed that the teacher thought the children were making the connections between mathematical ideas. These assumptions were based on the children's right or expected answers to the teacher's or textbook's questions. According to data, these right answers did not always mean that the children were understanding. It was recommended that the teacher involve the children in more situations for which risks could be taken. Also, the activities should include learning by problem solving and by trial and error. It was observed that the teacher felt uncomfortable when the students were working in unstable situations. The teacher's fears were a result of being held accountable for the children's learning.

Willoughby (1981) agreed with the first two recommendations in the National Council of Teachers of Mathematics' (NCTM) Agenda for Action as appropriate agenda for mathematics in the 1980s. However, he stated that any program of action that demands more time, knowledge, and creativity on the part of the teacher is unrealistic. On the other hand, he believed that authors and publishers should produce materials that will help teachers attain these goals. These materials should allow teachers to teach in such a way that mathematics is developed from situations that are real to students. The students should be able to use materials that they can manipulate in order to see the connection between their reality and mathematics.

Useful and interesting mathematical applications should be provided to ensure students that mathematics is useful and can be enjoyable. Thinking is the most basic skill in mathematics; therefore all students should be encouraged to think, and to see how thinking can help solve their problems. A final point suggested is that students should be encouraged to solve more extensive problems working together.

Whitaker (1982) stated that the very essence of mathematics is problem solving. Furthermore, the processes useful for solving mathematical problems may be applied in a variety of settings and disciplines. Whitaker also stressed eight contemporary goals for mathematics instruction. First, educators must guide students in the active investigation of the world of mathematics around them. Second, students need to develop an understanding that mathematics is a human discipline built upon understandings of the real world. Students must discover techniques of inquiry and develop the confidence to examine, question, solve and validate mathematical problems. Educators must aid students in mastering a core of essential skills related to mathematics that are necessary in a highly technological age. They should also help students in understanding that mathematics is the foundation for all scientific thought. Educators must identify and encourage mathematical creativity and help mathematically talented students appreciate the beauty of mathematics. Students need to be assisted in realizing that mathematics is characterized by structure, flexibility, rigor, induction, deduction and simplicity. Finally, educators must help students to like and enjoy the study of mathematics.

Worth (1981) recommended that the mathematics curriculum in An Agenda for Action (1980) is most important at the middle school level. Some of the recommendations suggest that teachers not always define problem solving in the conventional word problem form. Students should be allowed to participate in problem solving before complete skill mastery is accomplished. Mathematics activities should integrate drill in various ways. Teachers should not insist that students become highly skilled at paper-and-pencil calculations with numbers of more than two digits. Recommendations further suggest that teachers stop considering minimal competency as an adequate measure of mathematics achievement. Also, the mathematics program should be based on more sources than just textbook material. The middle school mathematics curriculum should benefit from two other recommendations which emphasized that curriculum be organized around problem solving and the power of calculators and computers be taken advantage of ..lly. Therefore, it is important that problem solving techniques and skills be considered as basic knowledge that can help students learn. Problem solving activities provide one of the best opportunities for application of skills. Because of our technological world, it is relevant that middle schoolers learn to utilize calculators and computers. Students should be allowed to explore, discover, and develop mathematical concepts with calculators and computers. Final suggestions to improve the middle school mathematics program included expanding the definition of basic skills; using different instructional strategies, materials, and resources; and providing a more flexible curriculum.

In considering other reasons for the problem, Hill (1980) stated that a crisis stage in school mathematics was becoming evident due to the fact that policy makers in education were diverting the public by a fixation on test scores. Three major problems were discussed. The first problem suggested that the school mathematics programs were not keeping up with technology which is requiring mathematical ability. The second problem deals with students not studying enough school mathematics to prepare them for the future, whether they are workers, consumers, or citizens. The third problem is presented by the shortage of qualified mathematics teachers in the secondary school classrooms.

Muth (1986) surveyed several popular sixth, seventh, and eighth-grade mathematics textbooks. It was found that word problems are not presented in a realistic manner. Mathematical problems, as solved in tne real world, usually consist of extraneous information. The observed textbooks made little attempt to include extraneous information in arithmetic word problems. This is not justified since several problems containing extraneous information are found on the National Assessment of Educational Progress (NAEP) word problems section. The results of the NAEP in 1979 indicated that students scored significantly lower in the problems containing extraneous information. According to the survey, it seems that children are not prepared for this type of problem. It was recommended that teachers systematically include extraneous information in word problems. However, this should not be done when students are learning a new concept. When the concept has been mastered, this strategy may enhance students' ability to deal with the concept in applied settings. It was suggested that teachers and text authors design word problems within realistic contexts. This would enable students to transfer their problem solving skills to real-life situations.

Suydam (1984) reported on recommendations made in An Agenda for Action by the National Council of Teachers of Mathematics for the 1980s. It was suggested that problem solving in mathematics consist of a wide variety of strategies, processes, and modes of presentation. In

Suydam's review of research in 1980, several findings were concluded. For example, when problem solving strategies are taught, students often use them to arrive at correct solutions. A variety of ways to solve problems is provided when students learn different strategies. There is no one way to solve all problems. Some strategies are more often used than others, and some are utilized at different stages of the problem solving process. A final conclusion suggested that students be given problems that they do not know how to solve. They should also be encouraged to attempt different strategies. Students should be exposed to problems that they must analyze, not just select the correct operation.

Stockdale (1985) compared data concerning mathematics textbook story problems in grades three through six during the 1980s to data collected by Mangru in the mid 1970s. Comparisons of data was validated by using Mangru's methodology which analyzed such variables as number of problems, setting of problems, use of clusters, number and order of operations for successful solution, use of clue words, presence of extraneous data, and so on. Achievement trends in mathematics problem solving for the sixth grade were collected and compared to the descriptive data for each time period. The comparisons indicated strong problem solving programs in the early 1970s which were accompanied by increasing achievement.

Weaker programs were found in the late 1970s with decreasing achievement, and a return to stronger problem solving programs for the 1980s which suggested that there would be an increase in achievement. Several variables served as indicators that solving word problems would strengthen in the 1980s. These variables consisted of an increase in the number of story problems, more use of a variety of unit types, more scientific-mechanical settings used, an increase in multi-step problems and multi-questions in problems, a variety of problems in a section, and problems dealt with more than computations. Furthermore, students are exposed to a wider variety of techniques for solving story problems.

Chukwu (1987) determined the effects of heuristic instruction in solving mathematical problems among eighth and ninth grade students. Two groups of subjects were used for the study. One group received instructions based on heuristic methods while the controlled group engaged in the traditional or textbook method. The subjects were pretested and then given two weeks of instruction. Everyday each group solved two non-routine problems which were the same. Worksheets were provided to all groups. Only the heuristic groups' worksheets consisted of ten heuristic strategies which the students were encouraged to follow. After the two week period a posttest was administered. Results indicated that the heuristic method of instruction was superior to the traditional textbook method.

Jenkins (1989) compared two strategies for teaching problem solving heuristics and improving problem solving performance. The two experimental strategies included heuristic attainment and heuristic assimilation. The experimental subjects were taught to recognize examples of three heuristics; reduction of problems, pattern recognition, and elimination. The controlled group solved problems by the three heuristics with no direct instructions. The subjects in the study were from middle and junior high schools in large urban and suburban mid-Atlantic schools. Schools were randomly assigned to the treatment levels. Nineteen classes were conducted at the ten schools. The treatment procedures were implemented by the classroom teachers for a ten week period. Non-significant treatment effects were determined by an analysis of covariance for correct problem classification, using the Improving Problem Solving Performance Test (IPSP) as covariate and an analysis of covariance for problem solving performance, using the same covariate. The results indicated that the experimental strategies showed a shift from contextual details to mathematical structure. Furthermore, neither strategy improved problem solving performance more than experiences in problem solving.

LeBlanc (1982) stated that the framework for solving problems is dependent upon four steps which include tell, show, solve, and check. These steps must be specifically taught to the students. In addition they must be shown how to apply the steps in a problem solving situation. The textbook can provide a source for teaching the problem solving process by using the four steps as an outline. In the first step, tell, the students should form an understanding of the problem. The teacher can help by asking such questions concerning the facts in the problem, questions asked in the problem, and questions related to the solution. In the show step the students demonstrate an understanding of the problem. The teacher should encourage the students to present the problem in several ways. For example, it can be dramatized, illustrated, a number sentence may be used, or a computational example may be shown. In the third step, solve, the problem is actually solved. Teachers can encourage students to tell why they used certain operations and stimulate the use of other strategies. In the final step, check, the problem solution is reviewed for accuracy. There is also a check to determine if the questions in the problem have been answered. The teacher should evaluate the problem solved in terms of process and accuracy. Furthermore, the students should check their answers to computations by using an inverse operation and answers should be judged according to their reasonableness. Teaching problem solving involves the same procedures, tell, show, solve and check. The standard textbook provides a ready source for teaching problem solving.

Johnson (1986) expressed the need for instructional strategies that would improve the cognitive processes of students. The area of mathematics is concerned with higher-level thinking processes. This study examined the use of cooperative learning as a method to improve problem solving skills at the elementary school levels. It involved the use of peer-tutoring and group approaches. Two groups were used in the study design. The Experimental Group had 28 teachers, who were trained in the use of Groups of Four Model, and 525 students. The Control Group contained 23 teachers and their 334 students. The Romberg-Wearne Problem Solving Test procedure was carried out at the beginning and end of the school year to measure problem solving achievement. The results showed that individual students of the Experimental Group scored significantly higher on the posttest than the Control Group. There was no significant difference in postachievement scores of the two groups at the class level of multiple regression analysis. Implications recommended cooperative learning as a model for improving problem solving achievement in the classroom.

Duncan (1986) studied what school children say and do while solving verbal mathematics problems in small groups. This study was done in compliance with the recommendation of the National Council of Teachers of Mathematics for 1980 which was to identify and analyze problem solving stra gies, as well as the settings where these strategies are most effective. Three groups of four members each were chosen and asked to solve a variety of routine and non-routine problems. Observations were recorded of all verbal interactions and computations for each group. The behaviors were analyzed in terms of the interactive functions involving the construction of mental representations or physical displays of the problems and the evaluation of these constructions. Representations were attributed to the contextual level, which refers to the linguistical interpretations of the problem situation, and the structural level, which deals with a structural statement of the problem. There were also evaluations concerning the understanding of the procedures for solving the problems. The results showed that the small groups, while solving problems, revealed several common patterns of behaviors. One similar pattern was the technique in which the student approached and stated the contextual elements of a verbal problem. A second pattern noticed was how students change the mode in which a problem is represented. This was shown by using manipulatives, diagrams, and tables. These findings display a practical use for group problem solving arrangements in the elementary classrooms.

Liebmann and Pannella (1987) emphasized how important it is that the classroom atmosphere foster creative thought. Improvements of students' problem solving skills will be gained when teachers allow exploration and sharing of ideas and strategies. The paired problem solving approach allows partners to share their techniques. The students are also less anxious during this type of approach. However, it is vital that the teacher provide motivation and control. It was suggested that a compromise between teacher-centered instruction and paired problem solving be used. This involves modeling by the teacher of new concepts and their uses. Students then can form groups to resolve solutions to similar problems. The teacher's major responsibilities consist of being a good listener, asking questions which stimulate discussions, and encouraging students' involvement.

Behle (1985) studied how teachers of seventh grade mathematics taught problem solving. Behaviors were noted for those teachers who were successful at teaching problem solving and those who were not successful. The study consisted of 15 volunteer teachers from 13 school systems both public and private. The Romberg-Wearne Problem Solving Test was used for the pretest and the posttest. The results indicated four teachers as being relatively successful and three as being less successful teachers. The less successful teachers were identified as doing much more for their students. For example, they set up problems and anticipated students' questions. The successful teachers frequently encouraged their students to think. Furthermore, the less successful teachers depended on the textbook for assignments; whereas, the successful teachers utilized a variety of sources. In addition, the successful teachers often gave additional credit when students corrected mistakes.

Zollman (1987) announced that researchers c mathematics education should seek for effective instructional methods for improving students' ability to solve problems. Developers of problem solving material should be concerned with transfer of learning which utilizes knowledge learned from one problem to be carried over to a new problem. In this study one aspect of transfer of learning and problem solving instruction has been considered. It dealt with problem presentation or the sequence in which tasks are presented to students. While the order of presentation was controlled, certain inner-structure attributes of the tasks, such as the number of variables, the number of conditions, or the cardinal size of the solution space, were varied to determine their effect on transfer of learning of mathematical processes. Results indicated no measurable transfer of learning when inner-structure attributes were varied whether the problems were presented less difficult-more difficult or more difficult-less difficult.

Babbitt (1986) studied the contribution of concepts and computation to children's problem solving performance in mathematics. It was stated that low achievers have poor computation skills, according to research, with little known about their mathematical concepts or problem solving ability. It was suggested that concept and computation skills affect problem solving performance. It was also proposed that by reducing the amount of computation, performance in problem solving would be improved. The study was divided into two sections. The subjects in study one consisted of 655 third through eighth grade students. The Iowa Test of Basic Skill's scores were used to determine how concepts and computation contributed to problem solving performance. It was found that computation significantly effected problem solving, but concepts were found to be even more significant. In the second study, calculators were used to reduce the computation load for three groups of low achieving students. A significant improvement in problem solving was shown by all students.

Wilson (1981) focused information on the trends for mathematics in the 1980s which were based on An Agenda for Action formed by the National Council of Teachers of Mathematics (NCTM). In references to problem solving, reading of mathematics text is a basic skill for which mathematics teachers share a responsibility to provide instruction. An important point to consider when teaching problem solving processes is that there may be a variety of approaches to a problem. The Agenda requested for a broader sense of basic skills. These skills might consist of estimation and approximation; collecting, organizing, presenting and interpreting data; measuring; mental computation; using calculators and computers, geometry and reasoning. In connection with the recommendation for taking full advantage of the power of calculators and computers, the Agenda emphasized several challenges to be faced. First, all students should have access to calculators and computers. Further, the use of these devices should be integrated into the core mathematics curriculum. There will be a need for materials that require the use of calculators and computers. Computer literacy should be a part of basic and essential skills. Also, the preparation, certification and continuing education of teachers on instructional use of computers are very important. The power of calculators and computers will have quite an effect on mathematics instruction.

Osborne (1982) reported that three statements of curricula recommendations for mathematics education advocate processes of problem solving and applying mathematics as the central concern of the curriculum. The present shift to processes of problem solving and of applying mathematics parallels the shift in reading literacy expectations. The rationale provided for this shift in mathematical literacy evolves on helping students acquire the capability to deal with the new and different situations of the current technological society. It was stated that schools do not have an adequate set of tools to implement a curriculum that stresses processes of problem solving and applying mathematics. Osborne also feels that textbooks must be supplemented greatly in order to cope with these goals. It was further suggested that learners with ability in mathematics have more elaborate memory mechanisms than those of lesser ability. Thus, memory is one of the key factors affecting success in problem solving. The teacher and curriculum developer should try to help students build effective memory. The scope and sequence in the curriculum can be improved by the appropriate use of the calculator and computer.

Shulte (1980) discussed four essential steps toward curriculum development for the 1980s which were based on recommendations of An Agenda for Action. He pointed out to emphasize extended calculation with multidigit numbers on pencil and paper ignores the availability of calculating devices. Estimation skills will become much more important with the increased use of calculators in computation. Although many students can compute by pencil and paper or with calculators, they cannot apply the operations correctly in story problem situations. Therefore, teachers much spend time helping students to examine the models for computation. For example, students should be able to interpret 5x6 as five sets of six, as adding six five times, and a variety of other ways. The major purpose of mathematics instruction is to enable students to solve problems. Thus, it is important that students be confronted at all levels with a variety of problem solving situations other than those from the textbook. Another essential area of consideration deals with measurement. Effective teaching of measurement requires much hands-on work in actual measurement situation. Also metric usage is continuing to increase. Therefore, students need experiences with metric measures. These suggestions must be implemented in order to ensure sound mathematics instruction in the future.

CHAPTER III

ANTICIPATED OUTCOMES AND EVALUATION INSTRUMENTS

Goals and Expectations

There were several goals in relation to this practicum. The primary goal was that the problem solving skills would be improved for the writer's fifth grade mathematics students and a group of seventh grade mathematics students. A secondary goal proposed to enhance students' attitudes toward problem solving in mathematics.

Behavioral Objectives

The following behaviors were expected at the completion of this practicum:

1. Fifty out of 70 of the students were to exhibit improvement in problem solving skills.

2. Sixty out of 70 of the students were to indicate improvement in their attitude toward solving word problems.

Measurement of Objectives

The following standards of performance were utilized to measure behavioral expectations:

1. a. When administered the problem solving component of the Iowa Test of Basic Skills (ITBS) pretest and posttest, 50 out of 70 of the students, following an 8-month

problem solving program, were to display an increase in their pretest percentage score by 20%.

b. Fifty out of 70 of the students were to show a gain in their pretest normal curve equivalent (NCE) by ten points.

2. When presented with a pretest and a posttest survey regarding attitudes toward problem solving, 60 out of 70 of the students were to exhibit a minimum improvement by ten points after completion of participation in an 8-month problem solving program (Appendix A).

The following assessment instruments were to be used to measure the standards of performance.

1. The problem solving component of the Iowa Test of Basic skills was to be used to assess performance of problem solving skills. The pretest scores were to be collected from the ITBS problem solving area which was administered in the spring (April) of 1989. Posttest scores were to be acquired following administration of the ITBS in the spring (April) of 1990. The testing time for the problem solving component consisted of 25 minutes. There were 27 items contained on the fifth grade level test and 29 for the seventh grade level.

The Iowa Test of Basic Skills (ITBS) is a widely used and well-respected test which provides a measurement of growth in fundamental skills including mathematics

(Airasian, 1985).

Nitko (1985) reviewed the Iowa Test of Basic Skills (ITBS) and stated that the revised Problem Solving Subtest has changed in significant ways. For example, the concepts and operations required to solve problems at a specific level have been introduced a year prior to the grade for which the level was intended. This change will indicate a student's ability to apply mathematical understanding to realistic problems. The Problem Solving Subtest consists of items in the categories of single-step addition and subtraction, a single-step multiplication and division, and multiple-step problems involving combinations of operations. The reviewer rated the ITBS as an excellent basic skills battery which measures skills possibly related to long-term goals of elementary schools.

2. The attitude survey consisted of ten questions regarding feelings toward problem solving in mathematics. The students were to respond to each question by selecting an answer based on a three-point scale indicating never (1), sometimes (2), or most of the time (3).

Table 4 illustrates how the behavioral objectives, measurement of objectives, assessment instruments, and plans for analyzing the results interact with one another.

Table 4

Comparison of Outcomes and Evaluation Instruments

Behavioral Objectives	Measurement of Objectives	Assessment Instruments	Plans for Analyzing Results
1. Fifty out of 70 of the students were to exhibit improvement in problem solving skills	1.a. . . . increase in pretest percentage scores by 20% b. . . . gain in NCE by ten points	1. Iowa Test of Basic Skills (Problem Solving Component)	1. Table
2. Sixty out of 70 of the students were to indicate improvement in positive attitude toward solving word problems	2. . . . exhibit a ten point improvement in pretest total points	2. Attitude survey	2. Table

CHAPTER IV

SOLUTION STRATEGY

Discussion and Evaluation of Possible Solutions

The concern about indequate mathematics skills for children has prompted much research, especially in the area of problem solving. Studies have indicated that this component of mathematics is inadequate and can be improved among children when the appropriate programs are implemented. The following literature presents recent studies and guidelines based on problem solving programs designed to improve children's skills regarding word problems.

Lee (1982) provided guidelines for assisting young children in successful problem solving. Many times elementary school children experience a feeling of helplessness when they are confronted with word problems. This leads children to just simply putting down numbers and performing some operation with no idea of how to solve the problem. Therefore, it is important that children develop some procedures or methods that can assist them in working confidently toward a solution. Elementary school children can use the following list which was adapted from Polya's (cited in Lee, 1982) heuristics.

Heuristics for Elementary School Children:

1. Understanding the Prc' em
   (a) What is involved in the problem?
   (b) What are the relationships among the involved items?
   (c) What are the questions to be answered?
2. Making a plan
   (a) Can drawing a picture help?
   (b) Can making a chart help to solve it?
   (c) Consider special cases and look for a pattern.
   (d) Consider one condition and then add another condition.
   (e) Have you solved a similar problem?
3. Carrying out the plan
   (a) Carry out the plan.
   (b) Check each step.
4. Looking back
   (a) Is your answer reasonable?
   (b) Try to find another way to solve it.
   (c) Make a similar problem.

Problem solving activities should be designed to allow students to use whatever resources they feel comfortable with in solving problems. The teacher should provide alternative methods for finding solutions. As students progress in problem solving activities, they modify their methods and build confidence in problem solving. To develop problem solving ability in the early stage, each session should take from 45 minutes to 60 minutes. There should be much teacher involvement through demonstrations and helping the students. After six or seven sessions, the teacher's involvement should be reduced. This reduction of teacher assistance will be replaced with the students' more active involvement. The solution should also be shared.

Sowder (1986) expressed the importance of the looking-back step in solving mathematics problems. Teachers efforts are often given to developing heuristics that may help in devising-a-plan step, such as in Polya's steps of understanding the problem, devising a plan, carrying out the plan, and looking back. However, the last step of looking back seems to be neglected. The looking-back step can provide students with a simpler solution possibility. Looking back can offer an exciting part of mathematics, the creation of conjectures or inferences. It can further show students mathematics in the making, instead of the consumption of polished mathematics. Looking back can also help to develop the attitude that it is more important how one gets answers than the answers. Looking back at a problem may also stimulate the generation of new problems and ideas which would encourage mathematical thinking.

Havel (1985) discussed an approach to problem solving in which children first categorize a problem before solving it. This approach encourages mastery of skills, as well as develops positive attitudes toward solving problems. In the initial stage it is suggested that awareness activities be carried out in order to enhance thinking, reasoning, and evaluation. A number of sheets of different word problems should be duplicated. Then students are asked to circle key words, act out problems to the class using a variety of manipulative devices, write a number sentence for the problem, draw a diagram or picture, select a strategy, solve the problem, and check to see if the answer sounds reasonable. A list of key words or terms used in word problems should be filed for students' reference when solving problems. The approach to problem solving can be administered during the regular mathematics period, in a learning center or on alternating days with the students' textbook assignment. The kinds of materials available to teachers include workbooks and textbooks from other classrooms or the library, textbooks from various publishing companies, library resources, enrichment books and kits from resource centers, and manipulative devices which can be used in categorizing and solving a word problem. The type of pages from which students can categorize word problems may consist of pages with a definite strategy, such as watching for key words or drawing a picture. Also, pages using the see-plan-do-check procedure may be included. Some pages may consist of word problems developed by the teacher. Finally, pages may be used from supplementary workbooks and textbooks which contain word problems that are relevant to students' daily lives. Furthermore, a list of categories or operations for which word problems are comprised may be used. The list should be appropriate for the students' grade level and skills. Students should know the concepts and how to do the computational problem in each category. A student must determine the category to which a word problem should be assigned. To implement this approach students may individually select their own word problems from the available materials. Each problem may be written on a note card with the appropriate category indicated. The card should also include the page number, resource book used, and the student's name. The student may then solve the problem on the card and label it correctly. A similar procedure may be followed as students work with a partner. The teacher should encourage success through verbal praise, provide individual attention to students as they select and work through their problem. Suggested ways of helping students may include helping the student to reword a problem, creating ideas for a drawing, and suggesting an alternate choice of answers to determine if the student is understanding the problem. Also, the teacher should provide the appropriate manipulative devices. Furthermore, goals should be set for the number of correctly solved word problems. Then awards, such as certificates, can be given to students who achieve this goal.

Fennell and Ammon (1985) suggested an effective strategy for teaching problem solving. This method requires children to write their own word problems. It involves students in a process that combines reading, critical thinking, and the collection and organization of data. The writing of mathematical word problems consist of Donald Graves' writing processes which include prewriting, writing, rewriting and revising, and publishing. During the prewriting stage, students are presented with rich sources for developing word problems, such as newspapers, magazines, air and rail schedules, menus, and maps. From such sources students are encouraged to create their own problem setting. The teacher's role is to encourage thinking. During the writing stage, the teacher should help edit by asking questions. Students should be urged to solve each other's problems. Also, the teacher should check to make sure that all problems are solvable. After the writing stage, students should be encouraged to revise and rewrite by scratching out words, adding others, and changing their writing so it will be effective. The final stage involves publishing or sharing of the word problem. This can be done by placing them on posters, file cards, overhead projector transparencies, or in learning centers. They can also be bound into individual or classroom books. The enthusiasm and understanding gained by this method of teaching word problems enhances the possibility that children will apply these problem solving skills to real life.

Burns (1988) stressed writing as a key component in developing students' mathematics thinking and understanding. Experiences in problem solving are started by setting up situations, creating problems, and asking questions. Children should be structured in small cooperative groups and should be urged to share with each other what they are thinking. Writing in mathematics has two advantages. First, it enhances cognitive development by making students use their reasoning. It allows them to explore, clarify, confirm, and extend their thinking and understanding. Second, writing permits the teacher to judge students' level of understanding in a way that is more revealing than simple worksheets. It is suggested that students be given time and encouragement in order to adjust to this new way of writing which requires them to analyze, synthesize, and describe thinking and reasoning. Four strategies were offered for teachers to help stimulate children to think and reason. First, teachers should focus on problems that require written responses, not simply numerical answers, when trying to teach number concepts. A good example was given when students were asked to examine the following sets of four consecutive numbers: 1, 2, 3, 4; 8, 9, 10, 11; 42, 43, 44, 45; 19, 20, 21, 22; 77, 78, 79, 80. Students in groups of four were asked to verify that each set had a difference of three between the first and last number. The teacher then suggested that the students look for other characteristics of the four consecutive numbers and write them down. Several responses were as followed: "If you add the first and the last number, you'll get an odd number; If you add all four numbers in each row, you'll get an even number." A second strategy is to use word problems that get students reasoning as they find answers. It is important to present problems in such a way that requires students to write out their answers and explain how they arrived at them. Another strategy encourages teachers to provide opportunities for presentation of students' thinking processes which were used in solving a problem. A better understanding of mathematics is developed when students describe their thinking processes and verify their solutions. While sharing with the class, students can hear each other's thoughts and get feedback from their own ideas. A final strategy involves using students' writing to assess their understanding of mathematics concepts. When students write, they give insight into what they think about a concept and how they reason. Furthermore, it lets students know that the teacher values what they are thinking.

Gilbert-Macmillan and Leitz (1986) stressed cooperative small groups as a method for teaching problem solving. The interaction among children in a small-group environment serves as a chief motivator for the learning process. When children share their solution processes with others, their thinking becomes stimulated. Good problem solvers do not simply change words into calculations to be performed. They first try to understand the problem and then they proceed through a process to conclude an answer. Children in small groups working together have many opportunities to assert themselves and to acquire experience in using mathematical language correctly. When this type of language is practiced, students develop active skills necessary for problem solving. Students may spend more time on task when they work in small groups as opposed to working individually in large groups. However, the effectiveness of small groups depends on a number of factors. For example, the composition of a group may influence its processes. The number of students in a group and their perceived social and academic status have been found to make the most difference. Less effective factors were how the group members are chosen, their ability, gender, and ethnicity. Groups consisting of three to five students were found to be required to achieve maximum participation with the most successful groups containing four members. Some of the key elements were stressed for training small groups to work effectively. First, the group tasks must be clear and specific. It is important to point out each member's unique ability, such as those who are better at reading, computation, drawing, and managing the groups' procedural activities. Students should become aware that they can learn from each other and should share the responsibility of learning how to solve each problem. Specific behaviors should be pointed out, such as listening carefully to group members as they speak and ensuring that each member participates frequently. The groups should be encouraged to ask each other questions, explain ideas in detail, draw pictures and debate various answers. Finally, training is essential in order for the students to learn to work cooperatively in small groups.

Rosenbaum et al. (1989) pointed out how children can solve word problems more effectively applying computational skills in small, cooperative groups. Many opportunities should be offered to children to have practices working with problem solving skills in cooperative groups. However, the size of the cooperative learning groups should be carefully regarded. It is advised to begin with activities consisting of partners and then transfer into activities containing groups of three or four. In order for cooperative learning to be effective, it is vital that students know how to help one another without giving the answers and that they know how to work together toward a common goal. Teachers can teach strategies to the whole class in modeling situations, such as using problem solving processes with diagrams, graphs, tables, charts, and pictures. Afterwards, the small, cooperative groups can practice the suggested procedures. As the students work in the groups, the teacher should help guide everyone so they will become involved. Cooperation is important among the group to enhance the sharing of ideas, staying on task, and the completing of the problem solving activity. In addition, the sharing of ideas can provide feedback to reinforce the skills taught by the teacher. The small group situation can also foster a non-threatening environment. Students are not as threatened when they make a mistake in front of two or three as opposed to a whole class. Students are more likely to stay on task and continue to be motivated by peer support.

Chisko (1985) described some techniques which can be used to encourage the use of analytical skills and compared this problem solving emphasis to a more traditional computational-skills approach. Analytical skills can be developed through techniques stressed in different areas. These areas include developing a positive attitude toward mathematics, encouraging activeness on the part of the students, and providing survival skills which encourage the practice of problem solving and analytical skills. An important characteristic of a good problem solver is having a low level of mathematics anxiety. It was suggested that students may complete a mathematics attitude survey during the initial classes to help reduce possible tension associated with mathematics anxiety. It was recommended that these attitudes consisting of both positive and negative experience be shared to allow students to see that they are not alone in their fears. Another important attribute to develop is student involvement. In order to learn mathematics, students must be active participants. Students must be allowed to articulate and communicate what they are thinking and doing. The authors suggested that students have the precise vocabulary of mathematics. This can be done by giving students a list of vocabulary words that are defined as each unit is introduced. Students should also be encouraged to read problems aloud. Group work and discussion further enhance student involvement. Another technique may be to have students generate their own mathematics problems. Involvement also serves as one of the most important goals of the survival-skills approach. Students must know how to take notes, to take a variety of tests, to read a mathematics text, to be flexible in methods of solutions and to work problems with multiple steps. These skills enable students to become good, active problem solvers.

Harvin (1987) compared three approaches to problem solving for fourth grade mathematics. The study involved three classes with each being presented a different approach to problem solving. Class One practiced problem solving in a structured classroom setting.

Problem solving was learned incidentally by Class Two, and Class Three followed the lessons as they appeared in the textbook. Each day Class One participated in problem solving strategies, such as guess and check, draw a picture, make a list, make a table, work backwards, look for a pattern, or logical reasoning. Class One worked on problems taken from books which accompanied the regular textbook. Each problem was presented to the children. They solved the problem by working together in groups on the first day. The next day the students worked individually as the teacher guided them with the procedures of understanding the problem, developing and carrying out a plan, finding the answers, and checking the problem. Class Two was designed whereby the teacher presented "real life" problems which may or may not have involved the strategies used by Class One. Each student worked individually. In Class Three the students were instructed by the textbook method, as the teacher directed the process. A pretest and a posttest, which was designed for use with the text, was administered to each of the three classes. Improvement was indicated in four of the seven categories for Class One, which received the directed instructions. Class Two, which was taught incidentally, showed little, if any, gain in using problem solving strategies; whereas, a few students in

Class Three mainly improved in using two strategies, drawing a picture and making a list. The results of the study revealed that problem solving strategies need to be taught to students. It was suggested that the daily exposure to problem solving activities may have been a key factor which contributed to Class One's improvements.

Thompson (1985) offered a strategy in problem solving which suggests looking for a pattern. To use this strategy one must start with simple versions of the problem and then discover a pattern or rule that can be utilized to locate the general solution. One example of this strategy is the staircase problem. If ten blocks are needed to form a staircase of four steps, how many blocks are needed to make ten steps? For the four-step staircase, one block is used for the first step, two blocks for the second, three blocks for the third step, and four blocks for the fourth. Thus, the total is found by adding. In order to find the total for the ten-step staircase, the pattern can be followed in the process of constructing the staircase. The number of blocks needed to add another step corresponds to the ordinal number of the new step. Therefore, the whole numbers from 1-10 can be added to find the number of blocks needed for the ten steps. Mathematics educators should strive to supply students with practices of this nature and involve students in discussions that help them think about when, why and how to solve problems.

Stiff (1986) indicated several strategies to improve students' reading comprehension of word problems. Comprehension guides help students understand word problems at both the literal and the operational levels. A comprehension guide for a word problem consists of literal statements and operational statements. Literal statements concern factual information found in the word problem. It is important to decide what the word problem actually says and determine the specific question that is to be answered. The operational statements express mathematical procedures necessary to solve the problem. Thus, it is important to determine which mathematical concepts and operations are needed to obtain a solution. Students tend to have difficulty because they do not use known information with that located in the statement of the problem. Solutions must be constructed on all available information. Three important steps are needed when developing a comprehension guide for students. Step one is to identify a word problem, such as those found in the mathematics textbook. Then the teacher should make declarative statements to explain the literal and operational content of the word problem. The final step is to construct both true and false statements about the problem at both levels, literal and operational. Comprehension guides are most effective when used once or twice a week to review mathematics topics in the form of word problems. Students can improve newly learned mathematics skills and concepts by using guides. Heterogeneous ability groups should be designed with three or four students in each. The same problem can be considered by each group. The guide for the word problem should be read by each student. Then a decision should be made about which statements are correct. At the beginning of the session a time limit should be established. The teacher should monitor the progress of each group. Finally, the teacher should indicate all correct statements to the class.

Vannatta and Hutton (1980) reported on a project in which hand-held calculators were introduced into the mathematics instruction for intermediate level students. The purpose of the project was to investigate the possibility of improving problem solving performance and increasing student interest in mathematics by using calculators. The calculators were used to reinforce computational skills, textbook problem solving, supplementary practice with large numbers, and extra problem solving outside the text. In conclusion, the project revealed several findings. For one, calculators seemed to enhance interest and motivation for most students. Calculator use was learned quickly, carefully, and accurately by most students. For the first year of the project sixth grade students showed a significant increase in problem solving performance. The following year calculator classes produced achievement in computation and problem application well above expectations on the California Achievement Test. Calculators can be experimented with in the classroom without fear of endangering computational skills provided they are properly utilized.

Description and Justification for Solution Selected

The solution implemented consisted of a structured problem solving program. The writer believed that this program would provide the appropriate solution and satisfy the stated goals. The program allowed for consistent practice to increase students' skills regarding word problems. It offered participation by all students within a class at the same time. It was implemented at little or no cost. The students were required to provide their own calculators which most students already owned. This program could be easily implemented during the regular mathematics class and integrated into the mathematics curriculum. It was very important to implement the program during the regular mathematics class since many of the students were only with their mathematics teacher one period of the day. Thus, the program was most applicable to the scheduling procedure for this school setting. The program offered a variety of techniques and strategies for working with word problems. It further provided a wealth of sources from which to select word problems. The use of calculators and a computer were used to enhance skills, as well as stimulate interest. The cooperative group activities provided students with a comfortable setting for working and sharing. This method for teaching problem solving skills surpassed other possible solutions, such as the routine textbook approach, because it provided the necessary opportunities for students to explore and apply skills. The solution implemented by the writer involved a structured problem solving program. The program was developed for the purpose of increasing students' problem solving skills.

Report of Action Taken

The establishment of pretest data was accomplished by collecting percentile and NCE scores from the problem solving component of the Iowa Test of Basic Skills (ITBS). This test was administered during the spring (April) of 1989. The test required that students complete about 27 problems during a timed session of 25 minutes.

The writer's two classes of fifth grade mathematics students and a seventh grade teacher's mathematics students participated in the 8-month structured problem solving program. Prior to implementation of the program all students were given a pretest attitude survey to determine their feelings toward problem solving (Appendix A). The results for each student were tallied and recorded on a class record sheet. Furthermore, letters were sent home to parents informing them about the special emphasis regarding problem solving in mathematics (Appendix B). The letter briefly described the program and requested parental support of their child's participation. The signed parent letters were returned and filed. In preparation for teaching problem solving skills, the writer and the seventh grade teacher attended a 5-day workshop, The Mathematics Solution (K-8), presented by Marilyn Burns and associates. The course concerned teaching mathematics through problem solving. The workshop focused on teaching problem solving in all areas of the mathematics curriculum. It also dealt with helping students apply mathematics skills to solve problems, organizing the classroom for cooperative learning, and using concrete materials to develop understanding of concepts. In addition, Burns and her associates stressed the importance of having a rich classroom environment that supports problem solving. A certificate of attendance was received for participation in the workshop (Appendix C).

The program was first introduced with an explanation of its purpose, which was to increase problem solving skills. The writer further explained the importance of problem solving as a vital part of mathematics. Examples were provided to demonstrate how valuable problem solving skills are in everyday life situations. The writer shared one experience she had whereby an adult approached her in a store and asked if a set amount of money would cover the cost of the two items held by the adult. The students were stunned by the adult's lack of ability to perform such a simple task. Hopefully, it stimulated the students to realize the necessity of being able to perform simple problem solving tasks.

The writer then discussed the procedures for the program. The 8-month program consisted of 20 minute problem solving sessions 3 days a week, Monday, Wednesday, and Friday. Each session occurred during the regular mathematics class period. During the initial stage of the program more time was allocated to allow the students an adjustment period to the structured program. In the event of time shortages, which were due to scheduled assemblies, testing periods, or inappropriate timing to depart from the regular scheduled lessons, arrangements were made to carry out the 20 minute session during an alternate time. The alternate time was generally held the following Tuesday or Thursday, especially for Group B and Group C. For Group A the time needed could often be extended through the next period since this group was self-contained in the afternoon.

A bulletin board was displayed to enhance the importance of problem solving and to stimulate interest. The students were encouraged to set goals for themselves in terms of solving problems correctly. Throughout the program, students were involved in a variety of problem solving activities selected from various sources. The teaching methods ranged from guided group instructions to independent student assignments. Guidelines and strategies for solving problems were introduced and reinforced all through the program. The writer and seventh grade teacher often provided guided lessons and activities for follow-up.

Cooperative small group learning served as a key component of the program. As students worked in their small groups of 3 or 4, they sometimes engaged in the same activity. Other times they were allowed to select word problems from different files which were located in a mathematics learning center. Individual groups generally worked on the same activity. The cooperative groups enabled the students to communicate and share their work with each other. One convenient way used to arrange groups was the selection of a card from a deck. All students choosing a king card went to a designated area, those selecting a queen card went to another space, and so forth.

Another way used to group students involved simply letting the student count off in a manner to form the number of groups needed. On some occasions students were allowed to form their own groups. Working in cooperative groups required an adjustment period. When the students discovered that they would not necessarily be working with a close friend, many expressed very negative views. However, after a few weeks the students seemed to enjoy working with different classmates. Many of the brighter students realized how helpful they could be to some of the slower students. The students seemed to develop a sense of pride in their work because the group served as a support team for successful experiences.

The writer circulated the room providing feedback and assisting whenever a group as a whole was unable to solve a problem. As the students finished, they were allowed to self-check their answers from keys which were filed for easy assess. Several keys for different activities were provided so students would not be delayed in checking. The writer stressed honesty in checking work throughout the program. Also, copies of a glossary of mathematical terms were on file for the students' use. The glossary was beneficial in helping to solve many problems.

Students recorded the total number of correct problems solved out of the total number worked during certain sessions. Their personal record sheet was filed in an individual file folder which was maintained by each student. The folders contained a list of key words often associated with the different operational signs. The folders were also used by the students as they filed their work at the end of each session. Furthermore, each student recorded on a classroom poster the total number of correct problems solved at the end of each 30 problems completed. There was a separate poster for each class participating in the program.

Calculators were used during most all sessions to aid the students in solving problems and to stimulate interest. The students were extremely excited about being allowed to use calculators. It provided the students with more time to concentrate on solving problems, instead of being delayed by computational errors. However, this did not free all students of computational errors since some students experienced problems with the use of a calculator.

Suggested guidelines were continuously provided to assist students as they solved problems. These guidelines consisted of understanding the problem, making a plan, carrying out the plan, and looking back. A poster illustrated the listed guidelines and was located in an appropriate place for student reference.

A variety of strategies were presented and used by the students. Some example strategies involved guess and check, draw a picture, make a table, use logical reasoning, find a pattern, work backwards, and solve a simpler problem. A problem solving strategies poster contained a list of strategies to help the students in planning. Problems were demonstrated by the writer and seventh grade teacher to illustrate the variety of strategies that can be used while solving problems. These strategies were introduced at different times during the program.

The techniques of presentation ranged from the use of an overhead projector to board work, and sometime individual seat activities. The students seemed to enjoy most the opportunities of going to the board demonstrating and discussing their solutions to problems. On many occasions the students would engage in competition matches to solve problems. It was interesting to view the different approaches that students used to solve the same problems. The students relied on the strategies of drawing a picture and searching for a pattern quite often.

In order to add a special touch to the program, the writer several times invited a mathematics consultant from the Regional Educational Service Agency (RESA) to share problem solving techniques. The constultant presented problems which focused on logical thinking activities. Sample strategy techniques were explained and students worked in cooperative groups to apply the different strategies. Only Group A and Group B received the special lessons offered by the consultant due to scheduling limitations.

A computer was also utilized to help develop problem solving skills. Since only one computer could be spared upon request from the library due to a limited supply, computer time for each student was arranged on a rotational basis. The librarian was most helpful in searching for appropriate problem solving software, as well as a variety of other excellent materials for the students and references for the writer.

Furthermore, as an addition to the program Group A viewed the educational program "Solve It." The program was scheduled for 15 minutes on Monday and Thursday which was not during any of the groups' regular scheduled sessions. Since Group A was self-contained, an appropriate arrangement was made to view the program segments which extended from October to February. The shows dealt with a variety of problem solving life situations and included many areas of the mathematics curriculum. As a follow-up activity for some of the shows, the writer would create mental mathematics problems and encourage the students to solve them. This provided the students with challenging experiences since they were not allowed to use paper and pencil. Those students yielding correct answers were rewarded with small favors. Mental mathematics problems truly excited the students, as well as the writer.

The seventh grade teacher who implemented the problem solving program with Group C followed basically the same procedures and guidelines as the writer. The students of Group C were offered menus of problem solving activities covering various areas of mathematics. From each menu students could select the activities in the order they preferred. Materials and worksheets were provided for the students as they worked in their cooperative groups. The students organized into their groups at least once a week. Group C also participated in timed activities whereby the small groups were challenged to see which group could correctly solve the most problems. Treats were given to the winning groups. In addition, Group C was given a problem of the week to solve and share.

The writer and seventh grade teacher periodically shared their activities and progression of the program. Both created an atmosphere which fostered positive attitudes and creative thinking. Praise and rewards were offered to all students exhibiting positive attitudes and successful achievement throughout the program. At the end of the program certificates were awarded to all participating students.

In comparison of Group A and Group B with regard to working conditions, it often seemed easier to work with Group B. This was mainly due to the smaller number of students, 18 in Group B as opposed to 30 in the Group A class. Also during the sessions with Group B, there was a Chapter I teacher in the room who offered special assistance and reinforcement for the students. About midway in the program, the writer relocated some of the small groups for Class A to the library during group work sessions to reduce the overload of students in the classroom. This seemed to provide a much better working environment for the students. However, the library was not always available for use. Group B also seemed to be at an advantage with respect to the time of day they received their mathematics period. Group B had mathematics first period each day, whereas Group A had mathematics after lunch in the afternoon. The writer feels that this aspect greatly affected the students' attention. The seventh grade teacher expressed no problems with the working conditions for Group C. Many students expressed positive attitudes toward the cooperati e group learning technique. Students from all classes revealed that they felt more confident and more relaxed with their work when working in small groups.

In concluding the program, the problem solving component of the ITBS was administered in the spring (1990) to obtain posttest percentile scores and NCE scores. The pretest and posttest scores were compared to determine improvements in students' problem solving skills. The posttest attitude survey was also given and total points for each student were tallied.

The principal of the school nominated the writer to receive a certificate from the governor of the state in recognition of the extensive work in the field of mathematics. The writer was also permitted to select an outstanding mathematics student to be honored. Both the writer and the student along with other selected teachers and students in the state are invited to an honorary banquet in the fall (1990) which will be hosted by the governor.

CHAPTER V

RESULTS, CONCLUSIONS, AND RECOMMENDATIONS

Results

The primary goal of the practicum was to organize and implement a structured problem solving program to improve the problem solving skills of the writer's fifth grade mathematics students and a group of seventh grade mathematics students. As a secondary goal, students were exposed to a positive environment during the program to enhance students' attitudes toward problem solving in mathematics.

The results of the posttest scores for Group B of fifth grade students and Group C of seventh grade students, which were based on the Iowa Test of Basic Skills, were positive. The scores for the other fifth grade class Group A, indicated little gain. According to one objective established for this practicum, 50 out of 70 students were to exhibit improvement in problem solving skills. In order to measure this behavioral expectation, it was expected that 50 out of 70 of the students, following an 8-month problem solving program, would increase their pretest percentage score by 20%. In reference to standards of performance, the projected objective was not obtained. In addition, the behavioral expectation of 50 out of 70 students showing a gain in their pretest normal curve equivalent (NCE) by ten points was not achieved. As a contributing factor, it may have been unrealistic to expect such a high increase in the students' pretest percentage scores and a high gain in pretest NCE points. The number of students, 50 out of 70, required to reach the desired level of achievement was a fair estimate if the students would have simply needed to show a positive gain. Another factor reflected the basic attitude that some students had developed due to past experience. Also, it is important to consider that changing attitudes and developing problem solving skils is a time consuming procedure.

The percentile scores and NCE scores from the problem solving component of the ITBS administered in the spring of 1990 served as completion data for the problem solving program. The posttest percentile scores and normal curve equivalents (NCEs) are recorded by grades and classes. Posttest scores are listed on Table 5 for Grade 5, Class A, and Table 6 for Grade 5, Class B. Table 7 indicates scores for Grade 7, Class C. The tables will also show information regarding the students' age and sex. An asterisk is used on the appropriate tables to represent students who were excluded from the program due to moving during the year or receiving ther services during the time of the program. The scores illustrated on Table 5 for Class A of fifth graders show that 6 out of 30 students scored below the

50th percentile. This would represent a 1% decrease in the number of students in class A falling below the 50th percentile. Scores on Table 6 for Class B of fifth graders, which was the lower level group, indicate still a number of students scoring below the 50th percentile with 13 out of 18. It is worth mentioning that 3 of the 13 students scoring below the 50th percentile in Group B scored at the 49th percentile. However, with reference to the 13 out of 18 of the students scoring below the 50th percentile, these results show quite an improvement from the pretest where 18 out of 19 of the students scored below the 50th percentile. Table 7 displays positive scores for Class C of seventh graders. In comparison of pretest scores with 6 out of 22 of the students exhibiting a score below the 50th percentile, the posttest revealed only 3 out of 22 of the students falling below this point. This marks a decrease in the number of students in Class C falling below the 50th percentile.

A comparison of Grade 5, Class A's pretest and posttest percentages, along with the differences between each, is illustrated in Table 8. When pretest and posttest percentage scores were compared for each student, data indicated that 15 out of 30 of the students had increased their pretest percentage scores. Only 3 students in Class A reached the desired expectation of improving by

Table 5

Posttest Normal Curve Equivalents and Percentiles - April, 1990 - Grade 5 - Class A

Student Number	Age	Sex	NCEs	Percentiles
1	10	F	63	73
2	11	F	41	33
3	11	F	87	96
4	10	M	80	92
5	10	M	80	92
6	11	F	56	62
7	11	M	58	65
8	*	*	*	*
9	11	F	75	88
10	11	M	66	78
11	11	M	49	49
12	11	M	22	9
13	11	M	66	78
14	11	F	44	38
15	11	F	53	56
16	11	F	87	96
17	11	F	60	68
18	10	M	58	65

(table continues)

Student Number	Age	Sex	NCEs	Percentiles
19	10	F	70	83
20	11	M	63	73
21	10	F	63	73
22	*	*	*	*
23	11	F	80	92
24	11	M	60	68
25	11	M	63	73
26	11	F	60	68
27	12	F	38	28
28	11	F	56	62
29	11	F	70	83
30	11	F	44	38
31	*	*	*	*
32	11	F	63	73
33	12	M	56	62

* = Excluded from the program.

Table 6

Posttest Normal Curve Equivalents and Percentiles - April, 1990 - Grade 5 - Class B

Student Number	Age	Sex	NCEs	Percentiles
1	11	F	52	54
2	12	F	58	65
3	11	M	41	33
4	11	M	49	49
5	10	F	38	28
6	11	M	49	49
7	11	M	52	54
8	11	M	41	33
9	*	*	*	*
10	12	F	44	38
11	11	F	56	62
12	11	M	38	28
13	12	F	26	33
14	11	M	38	28
15	13	M	58	65
16	11	M	34	22
17	12	F	30	17
18	12	M	34	22
19	11	M	49	49

* = Excluded from the program.

Table 7

Posttest Normal Curve Equivalents and Percentiles - April, 1990 - Grade 7- Class C

Student Number	Age	Sex	NCEs	Percentiles
1	13	M	62	72
2	14	M	58	65
3	13	M	43	37
4	12	F	36	26
5	13	M	58	65
6	14	M	50	49
7	13	M	52	55
8	12	M	62	72
9	12	F	61	69
10	13	F	87	96
11	12	F	68	80
12	13	F	62	72
13	14	M	65	76
14	13	F	55	60
15	13	F	80	92
16	13	F	62	72
17	15	M	55	60
18	13	F	80	92

(table continues)

Student Number	Age	Sex	NCEs	Percentiles
19	12	F	80	92
20	13	M	62	72
21	13	F	55	60
22	12	F	55	60

Table 8

Comparison of Pretest and Posttest Percentiles -

Grade 5 - Class A

Student Number	Pretest Percentiles	Posttest Percentiles	Percentile Increase or Decrease
1	63	73	10
2	39	33	- 6
3	99	96	- 3
4	72	92	20*
5	87	92	5
6	75	62	-13
7	63	65	2
8	(45)	-	-
9	93	88	- 5
10	75	78	3
11	62	49	-13
12	21	9	-12
13	75	78	3
14	61	38	-23
15	39	56	17
16	98	96	- 2
17	39	68	29*

(table continues)

Student Number	Pretest Percentiles	Posttest Percentiles	Percentile Increase or Decrease
18	83	65	-18
19	93	83	-10
20	72	73	1
21	75	73	- 2
22	(96)	-	-
23	96	92	- 4
24	61	68	7
25	51	73	22*
26	61	68	7
27	21	28	7
28	75	62	-13
29	87	83	- 4
30	21	38	17
31	(61)	-	-
32	67	73	6
33	78	62	-16

( ) = Excluded from pretest sum

* = Indicated a 20% increase in percentile score.

Summary of Percentile Scores - Table 8

Total Number Tested (pre and post)	30
Sum of Pretest Percentiles	2002
Sum of Posttest Percentiles	2014
Pretest Percentile Mean	66.7
Posttest Percentile Mean	67.1
Gain* or Loss	0.4

an increase of 20%. To focus on the class as a whole, the pretest percentile mean score was 66.7 and the posttest percentile mean was 67.1. This pointed out a slight gain of 0.4 percentile for Class A.

Similar results were displayed in Table 9 as pretest and posttest normal curve equivalents (NCEs) were compared for Class A. Four students obtained an NCE gain of 10 points to meet the behavioral objective. Overall 14 out of 30 students of Class A demonstrated a positive NCE gain. A loss of 0.6 was found for Class A upon comparing the NCE pretest and posttest averages.

When pretest and posttest percentile scores were compared for Grade 5, Class B, a substantial gain was indicated. Although only four students exhibited a 20% increase in their percentile scores, 11 out of 18 of the students showed a positive gain in pretest percentile scores. An asterisk is used to recognize those students who accomplished the expected objective. The results for the total number of students yielded a pretest percentile mean of 32.8 and a posttest percentile mean of 39.4. Examination of these percentile mean differences displayed an outstanding gain of 6.6. A comparison of the pretest and posttest percentages, along with increases or decreases is shown on Table 10.

The results from pretest and posttest NCE comparison for Grade 5, Class B pointed out strong improvements. The

Table 9

Comparison of Pretest and Posttest Normal Curve Equivalents (NCEs) - Grade 5 - Class A

Student Number	Pretest NCEs	Posttest NCEs	NCE Gain
1	57	63	6
2	44	41	- 3
3	99	87	-12
4	63	80	17*
5	74	80	6
6	64	56	- 8
7	57	58	1
8	(47)	-	-
9	80	75	- 5
10	64	66	2
11	56	49	- 7
12	33	22	-11
13	64	66	2
14	56	44	-12
15	44	53	9
16	94	87	- 7
17	44	60	16*
18	70	58	-12

(table continues)

Student Number	Pretest NCEs	Posttest NCEs	NCE Gain
19	80	70	-10
20	63	63	0
21	64	63	- 1
22	(87)	-	-
23	87	80	- 7
24	56	60	4
25	51	63	12*
26	56	60	4
27	33	38	5
28	64	56	- 8
29	74	70	- 4
30	33	44	11*
31	(56)	-	-
32	59	63	4
33	66	56	-10

( ) = Excluded from pretest sum

* = Indicated an NCE gain of 10 points

Summary of NCE Scores - Table 9

Total Number Tested (pre and post)	30
Sum of Pretest NCEs	1849
Sum of Posttest NCEs	1831
Pretest NCE Average	61.6
Posttest NCE Average	61.0
Gain or Loss*	- 0.6

Table 10

Comparison of Pretest and Posttest Percentiles -

Grade 5 - Class B

Student Number	Pretest Percentile	Posttest Percentiles	Percentile Increase or Decrease
1	39	54	15
2	33	65	32*
3	8	33	25*
4	36	49	13
5	39	28	-11
6	36	49	13
7	61	54	- 7
8	26	33	7
9	(21)	-	-
10	21	38	17
11	16	62	46*
12	39	28	-11
13	36	13	-23
14	40	28	-12
15	45	65	20*
16	36	22	-14
17	8	17	9
18	26	22	- 4

(table continues)

Student Number	Pretest Percentile	Posttest Percentiles	Percentile Increase or Decrease
19	45	49	4

( ) = Excluded from pretest

* = Indicated a 20% increase in percentile score.

Summary of Percentile Scores - Table 10

Total Number Tested (pre and post)	18
Sum of Pretest Percentiles	590
Sum of Posttest Percentiles	709
Pretest Percentile Mean	32.8
Posttest Percentile Mean	39.4
Gain* or Loss	6.6

behavioral expectation of obtaining an NCE gain of 10 points was established by 6 students. In fact, 2 students even exceeded an increase above 20 points. The difference in Class B's pretest NCE average of 39.8 and posttest NCE average determined a very positive 3.9 increase. The information concerning Grade 5, Class B's pretest and posttest NCE comparison with differences is illustrated in Table 11.

Grade 7, Class C's comparison of percentile scores is displayed in Table 12. Positive results were accomplished by 16 out of 22 of the students in Class C. Three students reached the goal of increasing their pretest percentile by 20%. The pretest percentile mean was calculated at 63.3, whereas the posttest percentile mean averaged to 67.9. The difference revealed an encouraging gain of 4.6.

Although just 3 students from Class C reached the desired objectives in terms of pretest percentile increase, 5 students acquired the needed NCE gain. These 5 students exhibited scores on the posttest that were at least 10 points higher than their pretest scores. The total number of students showing an improvement consisted of 16 out of 22. This ratio would indicate that a majority of the class produced positive results. Another finding for the seventh grade class showed that an NCE gain of 3.1 was demonstrated when the pretest NCE average and the posttest NCE average

Table 11

Comparison of Pretest and Posttest Normal Curve Equivalents (NCEs) - Grade 5 - Class B

Student Number	Pretest NCEs	Posttest NCEs	NCE Gain
1	44	52	8
2	41	58	17*
3	20	41	21*
4	43	49	6
5	44	38	- 6
6	43	49	6
7	56	52	- 4
8	37	41	4
9	(33)	-	-
10	33	44	11*
11	29	56	27*
12	44	38	- 6
13	43	26	-17
14	45	38	- 7
15	47	58	11*
16	43	34	- 9
17	20	30	10*
18	37	34	- 3

(table continues)

Student Number	Pretest NCEs	Posttest NCEs	NCE Gain
19	47	49	2

( ) = Excluded from pretest sum

* = Indicated an NCE gain of 10 points

Summary of NCE Scores - Table 11

Total Number Tested (pre and post)	18
Sum of Pretest NCEs	716
Sum of Posttest NCEs	787
Pretest NCE Average	39.8
Posttest NCE Average	[illegible]
Gain or Loss	3.9

Table 12

Comparison of Pretest and Posttest Percentiles -

Grade 7 - Class C

Student Number	Pretest Percentiles	Posttest Percentiles	Percentile Increase or Decrease
1	89	72	-17
2	58	65	7
3	28	37	9
4	33	26	- 7
5	42	65	23*
6	64	49	-15
7	18	55	37*
8	66	72	6
9	66	69	3
10	93	96	3
11	74	80	6
12	69	72	3
13	74	76	2
14	58	60	2
15	78	92	14
16	37	72	35*
17	89	60	-29
18	85	92	7

(table continues)

Student Number	Pretest Percentile	Posttest Percentiles	Percentile Increase or Decrease
19	78	92	14
20	78	72	- 6
21	46	60	14
22	69	60	- 9

* = Indicated a 20% increase in percentile score

Summary of Percentile Scores - Table 12

Total Number Tested (pre and post)	22
Sum of Pretest Percentiles	1392
Sum of Posttest Percentiles	1494
Pretest Percentile Mean	63.3
Posttest Percentile Mean	67.9
Gain* or Loss	4.6

were compared. Table 13 illustrates NCE pretest and posttest comparison outcomes for Grade 7, Class C.

In concluding a summary of findings for all participates' percentile scores, positive outcomes ..ere established. In reference to the 70 students tested, 42 yielded an increase in their pretest percentile scores. This would represent improvement by more than half of the students participating in the problem solving program. It is evident that a total of 10 students satisfied the expected behavioral objective of making a 20% increase in pretest percentile scores. The cumulative data produced a pretest percentile mean of 56.9 and a posttest percentile mean of 60.2. The difference would represent a 3.3 gain for the total students in the program. In addition, there was a postive NCE gain of 1.8 with respect to all participates when the pretest, 54.9, and the posttest, 56.7, NCE averages were compared. Fifteen students reached the desired objective of acquiring a 10 point increase in their NCE pretest score. Regarding all 70 students, 41 students improved their pretest NCE scores. Thus, a majority of all participants in the problem solving program exhibited a gain. A summary of the cumulative results are shown on the following list.

Cumulative Summary of all Participants' Percentile Scores:

Total Number Tested	70
Sum of Pretest Percentiles	3,984

Table 13

Comparison of Pretest and Posttest Normal Curve Equivalents (NCEs) - Grade 7 - Class C

Student Number	Pretest NCEs	Posttest NCEs	NCE Gain
1	76	62	-14
2	54	58	4
3	38	43	5
4	41	36	- 5
5	46	58	12*
6	57	50	- 7
7	31	52	21*
8	59	62	3
9	59	61	2
10	82	87	5
11	63	68	5
12	60	62	2
13	63	65	2
14	54	55	1
15	66	80	14*
16	43	62	19*
17	76	55	- 8
18	72	80	8

(table continues)

Student Number	Pretest NCEs	Posttest NCEs	NCE Gain
19	66	80	14*
20	66	62	- 4
21	48	55	7
22	60	55	- 5

* = Indicated an NCE gain of 10 points

Summary of NCE Scores - Table 13

Total Number Tested (pre and post)	22
Sum of Pretest NCEs	1,280
Sum of Posttest NCEs	1,348
Pretest NCE Average	58.2
Posttest NCE Average	61.3
Gain* or Loss	3.1

Sum of Posttest Percentiles	4,217
Pretest Percentile Mean	56.9
Posttest Percentile Mean	60.2
Gain* or Loss	3.3

Cumulative Summary of All Participants' NCE Scores:

Total Number Tested	70
Sum of Pretest NCEs	3,845
Sum of Posttest NCEs	3,966
Pretest NCE Average	54.9
Posttest NCE Average	56.7
Gain* or Loss	1.8

The second objective for this practicum required that 60 out of 70 students indicate improvement in their attitude toward solving word problems. As a measure for this objective, 60 out of 70 of the students were expected to exhibit a minimum improvement by 10 points after completion of participation in an 8-month problem solving program. The expectation of this objective was not accomplished for several reasons. One factor which should have been considered was the point range allowed for improvement. Many students' pretest totals did not make allowances for an increase of 10 points. For example, if a student scored 25 points on the pretest, a 10 point gain could not have been achieved when the total points were 30. Some of the students tended to score higher on the pretest survey than expected. Also, changing attitudes is a procedure that takes time. As a first year program, it may have been sufficient enough to expect any positive improvement. The results concluded that 4 students accomplished the desired expectation of gaining 10 points. However, a large number, 47 yielded a score which showed improvement. The results for each student's individual response scores for the pretest attitude survey related to problem solving are presented in Appendix D. Posttest attitude survey outcomes for all students are shown in Appendix E.

A comparison of the pretest and posttest scores on the problem solving attitude survey for Grade 5, Class A is illustrated in Table 14. As shown, 2 students acquired the expected objective of improving by 10 points. In addition, 17 out of 30 students showed improvement. The overall class had a gain of 89 total points.

Table 15 reveals Grade 5, Class B's pretest and posttest attitude survey comparison. There was only 1 student in this class with a 10 point gain. However, there were just 2 students expressing a drop in points. Altogether 13 students had a positive gain toward increasing their attitude concerning problem solving. This would represent a majority of the total students with an improvement. The total points gained for the class was 57.

One student from Grade 7, Class C reached the 10 point expected gain on the problem solving attitude survey.

Table 14

Comparison of Pretest and Posttest Scores on the Problem Solving Attitude Survey - Grade 5 - Class A

Student Number	Pretest Total	Posttest Total	Increase or Decrease
1	16	24	8
2	14	21	7
3	16	11	- 5
4	23	25	2
5	12	21	9
6	16	22	6
7	22	21	- 1
8	(16)	-	-
9	14	28	14*
10	10	17	7
11	12	12	0
12	19	21	2
13	26	23	- 3
14	14	20	6
15	14	22	8
16	14	19	5
17	25	23	- 2
18	17	26	9

(table continues)

Student Number	Pretest Total	Posttest Total	Increase or Decrease
19	16	22	6
20	21	21	0
21	25	25	0
22	(23)	-	-
23	19	15	- 4
24	30	30	0
25	25	20	- 5
26	16	20	4
27	25	20	- 5
28	27	26	- 1
29	16	26	10*
30	17	25	8
31	(16)	-	-
32	12	18	6
33	22	20	- 2

( ) = Excluded from Pretest Total

* = Indicated a 10 point improvement

Summary of Attitude Survey Results - Table 14

Total Number with Pre and Posttest Scores	30
Sum of Pretest Totals	555
Sum of Posttest Totals	644
Gain* or Loss of Group's Total Pcints	89

Table 15

Comparison of Pretest and Posttest Scores on the Problem Solving Attitude Survey - Grade 5 - Class B

Student Number	Pretest Total	Posttest Total	Increase or Decrease
1	19	24	5
2	19	15	- 4
3	14	21	7
4	24	30	6
5	19	22	3
6	17	21	4
7	24	22	- 2
8	20	24	4
9	(15)	-	-
10	18	22	4
11	17	21	4
12	19	19	0
13	16	20	4
14	17	21	4
15	20	22	2
16	17	18	1
17	17	21	4
18	24	24	0

(table continues)

Student Number	Pretest Total	Posttest Total	Increase or Decrease
19	14	25	11*

( ) = Excluded from Pretest Total

* = Indicated a 10 point improvement

Summary of Attitude Survey Results - Table 15

Total Number with Pre and Posttest Scores	18
Sum of Pretest Totals	335
Sum of Posttest Totals	392
Gain* or Loss of Group's Total Points	57

Furthermore, 17 out of 22 displayed improvement. The gain of the group's total points was 54. Data demonstrating a comparison of the scores for Grade 7, Class C are shown on Table 16.

In summary of the objective to improve attitudes toward problem solving, 4 students increased their scores by 10 points or more. Furthermore, 47 students showed some degree of improvement. Students often verbally expressed their positive feelings about the problem solving program.

Conclusions

The primary focus of this practicum was to implement a structured mathematics program to improve the problem solving skills of the writer's fifth grade students and a seventh grade teacher's students. Improvement in the students' attitude toward solving word problems served as a secondary concern.

Findings indicated that the implementation of the structured mathematics program produced an increase in problem solving skills for the students. As it was pointed out in the results, 10 students out of 70 increased their percentage score by 20% or more, while 42 of the total participants found some degree of improvement. In addition, 15 students obtained an increase in their NCE pretest score of 10 points or more. Out of the 70

Table 16

Comparison of Pretest and Posttest Scores on the

Problem Solving Attitude Survey - Grade 7 - Class C

Student Number	Pretest Total	Posttest Total	Increase or Decrease
1	20	24	4
2	24	25	1
3	20	21	1
4	21	23	2
5	22	24	2
6	20	24	4
7	17	22	5
8	24	26	2
9	20	25	5
10	21	25	4
11	22	26	4
12	20	20	0
13	20	25	5
14	16	27	11*
15	18	23	5
16	18	23	5
17	20	20	0
18	22	23	1

(table continues)

Student Number	Pretest Total	Posttest Total	Increase or Decrease
19	24	18	- 6
20	22	25	3
21	26	26	0
22	23	19	- 4

* = Indicated a 10 point improvement

Summary of Attitude Survey Results - Table 16

Total Number with Pre and Posttest Scores	22
Sum of Pretest Totals	460
Sum of Posttest Totals	514
Gain* or Loss of Group's Total Points	54

participating students, 41 indicated some improvement in their pretest NCE score. In regard to the overall outcome of the program, a 1.8 NCE gain was achieved. There was also a difference of 3.3 gain when percentiles were compared. These findings reinforce the fact that a structured program focusing on strategies and cooperative group learning, can enhance problem solving skills for fifth and seventh grade level students.

Literature supported this program as Harvin (1987) compared different approaches to teaching problem solving to fourth grade students. Class One participated in a structured mathematics setting whereby the approach involved the students in using problem solving strategies. These students received guidance from the teacher, as well as worked in cooperative groups. Class Two was presented with "real life" problems, not necessarily involving the use of strategies and Class Three was instructed by the textbook method. Results showed greater improvements for students in Class One who were taught problem solving strategies.

Rosenbaum, et al. (1989) suggested that children can solve word problems more effectively by working in small cooperative groups. It was further recommended that strategies are taught in modeling situations and students are involved in cooperative group work.

Johnson (1986) also advised cooperative learning as a model for improving problem solving achievement in the classroom. The writer's fifth grade students and the seventh grade teacher's students tended to work well in cooperative groups. After the teachers presented a variety of strategies, the students applied them to assist in solving problems. As students began to develop strategy skills, they did not seem to be at such a loss in attempting to solve problems.

The opportunities of group work allowed the students to share ideas and help each other. It also seemed to strengthen students' willingness to attack word problems. Many students who usually would not express their thoughts concerning problems did so in the small group arrangements. The sharing of students' work truly encouraged involvement and reinforced different approaches for solving problems. Students loved to present their solutions whether orally or through demonstration.

Liebmann and Pannella (1987) emphasized the importance of fostering creative thought in the classroom. When teachers provide opportunities for exploration and sharing of ideas and strategies, students problem solving skills will improve.

The technique of providing a variety of activities helped to maintain the students' interest and enthusiasm. Students especially enjoyed activities which required manipulatives. They also acquired much satisfaction when competing to solve problems. However, the writer and seventh grade teacher had to be careful when providing rewards during competition. Rewards were always given for correct answers only and to as many students as possible.

The students' procedure of being able to select activities from a variety of sources and maintain individual file folders of their work, helped to develop a sense of pride. The added feature of students being allowed to utilize calculators greatly enhanced students' motivation and success with word problems. The use of calculators enabled the students to concentrate on thinking through appropriate solutions to problems, instead of being hindered by computational difficulties. The students were extremely excited about being able to use a calculator in the classroom. It added much to building their enthusiasm and positive attitude. Most students used their calculators during the acceptable times. The use of a computer in the classroom was also beneficial although its use was limited.

To support the use of calculators in the classroom, Vannatta and Hutton (1980) reported on a project which investigated the possibility of improving problem solving performance and increasing students' interest in mathematics by using calculators. The conclusion of their findings revealed that calculators enhance interest and motivation for most students. Sixth grade students showed a significant increase in problem solving performance for the first year of the project. Their achievement exceeded well above expectations for problem application on the California Achievement Test.

In discussion of the second objective, which expected students to exhibit improvement in their attitude toward solving word problems, the writer was pleased with the outcome. Although only 4 students met the requirements of improving their pretest score on the attitude survey by 10 points, 47 students displayed an improvement. This marks an improvement by a majority of the students.

To take a closer account of the results, Grade 5, Class A had 17 students showing an improvement in attitude. Grade 5, Class B had 13 students gaining in a positive attitude. Finally, 17 students of Grade 7, Class C showed an improvement. In reference to developing a positive attitude, many students seemed to improve more than the scores indicated.

Some degree of frustration was experienced by Grade 5, Class A due to the size of the class and the fact that it was taught during the afternoon. Some students did not seem to be as settled down in the afternoon as opposed to the morning. The climate in the afternoon sometimes was also not as comfortable. One very bright student in particular consistently maintained a negative, outspoken attitude toward problem solving even when successful experiences occurred and praise was offered.

The writer suggests that developing positive attitudes concerning problem solving is an ongoing procedure. The writer and seventh grade teacher provided encouragement, praise, and incentive rewards throughout the problem solving program. An atmosphere was provided which fostered thinking and opportunities for success. To reinforce this idea, Whitaker (1982) suggested that educators help students enjoy the study of mathematics.

Implications from this practicum reflect evidence that a structured problem solving program can improve skills related to solving word problems. It is further necessary that students engage in problem solving activities in an atmosphere that creates thinking, promotes involvement, and develops positive attitudes in mathematics in order to acquire improvements.

In summary of the results for this practicum, improvements were gained by students participating in the structured mathematics program. It was determined that 42 out of 70 of the students gained an improvement. Ten students increased their pretest percentile score by the expected objective of 20%. Also, 15 students had an NCE gain of 10 points as desired, whereas 41 students demonstrated some degree of improvement. The decline of a - 0.6 in NCE scores established by Grade 5, Class A attributed to a fall in the total results. The most improvements were acquired by Grade 5, Class B with a class NCE gain of 3.9. Grade 7, Class C also showed an outstanding NCE gain of 3.1 The combined results of all participating students produced an NCE gain of 1.8. The writer viewed the overall results as positive. Through a variety of guided activities, cooperative learning, exposure and application of various strategies, and the use of calculators, students improved scores on the problem solving component of the Iowa Test of Basic Skills. Implementation of a structured mathematics program, as designed for this practicum, can improve problem solving skills.

In addition, the students revealed improvements with regard to their attitude about problem solving. Four students improved their total points from the pretest attitude survey by 10 points or more. Forty-seven students, however, obtained an increase in their pretest total. Positive reinforcement and a pleasant atmosphere toward problem solving resulted in improved attitudes.

The concern for the development of adequate problem solving skills for children must be recognized in the mathematics program. The process of problem solving should be started at an earlier age, when children are eager to search for answers and before they have a chance to develop the habit of frustration when confronted with a problem. Since our society requires the constant ability of being able to solve problems, children must be equipped with the necessary skills to function in daily life situations. Many students involved in the problem solving program became aware of its importance. They also learned that activities requiring them to think and solve problems could be pleasurable experiences and rewarding. This practicum provided guidelines which could be helpful in developing adequate problem solving skills.

Recommendations

The writer would make the following recommendations to anyone wishing to replicate this program:

1. It would be beneficial to provide problem activities that related to all areas of the curriculum.

2. There should be provisions to formally evaluate students' progress periodically during the program. This would facilitate the analysis of specific needs.

3. Daily attention devoted to the development of problem solving skills may be more effective.

4. Parental involvement at home may be a valuable resource to utilize.

Dissemination

The results gathered from this practicum will be shared with the superintendent and principal of the school system. Furthermore, as Chapter I coordinator, the practicum results will be discussed with the Chapter I mathematics teachers and possibly many aspects will be utilized.

The writer's plans are to continue the problem solving program for the next school term. This intention reflects the students' progress along with their development of positive attitudes.

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APPENDIX A

ATTITUDE SURVEY RELATED TO PROBLEM SOLVING

APPENDIX A

Attitude Survey Related to Problem Solving

Grade Level ________ Student Number ________

Students,

Thank you for participating in this survey. The survey is being conducted to determine feeling toward problem solving in mathematics.

Please **circle** the appropriate response for each item.

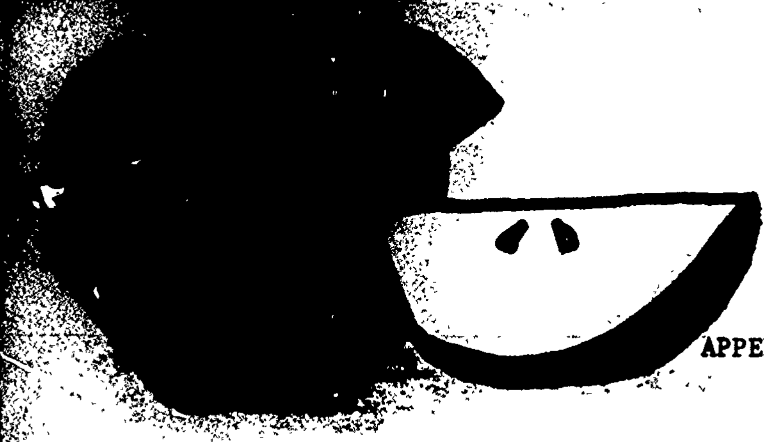
	Never 1	Sometimes 2	Most of the Time 3
1. Do you ever work word problems when not assigned	1	2	3
2. Do you willingly solve word problems?	1	2	3
3. Do you enjoy solving word problems?	1	2	3
4. Do you have positive experiences when trying to solve word problems?	1	2	3
5. Are word problems fun?	1	2	3
6. Do you feel successful when solving word problems?	1	2	3
7. When the teacher assigns problems to solve, are your thoughts pleasant?	1	2	3
8. Is there a need to solve word problems in mathematics?	1	2	3
9. Would you prefer to have more problems to solve than those in the textbook?	1	2	3
10. Would you like writing your own word problem to solve?	1	2	3

Thank you,

Deborah Hawver

APPENDIX B

LETTER GRANTING PARENTAL SUPPORT



APPENDIX B

August 23, 1989

Dear Parents,

The concern about inadequate mathematics skills for children has prompted much research, especially in the area of problem solving. Studies have indicated that this component is inadequate and can be improved among children when the appropriate programs are implemented.

As I review mathematics scores of the children I teach, it is evident that many students lack skills in this area. It is my plan for the new year to involve the class in a structured problem solving program which will increase your child's skills in solving word problems. The program will be implemented during the regular mathematics class for 20 minutes, three days a week. Your child will become involved in many problem solving activities throughout the year. Some of the activities will require the use of a calculator. If possible, please try to acquire a calculator for your child to use at school. Please put his or her name on the calculator before bringing it to school. It is my intent that your child receive the experiences necessary to deal with everyday problem solving situations.

I respectfully request that you encourage and work with your child at home concerning problem solving skills.

Sincerely,

Mrs. Deborah A. Hawver

Please sign this letter granting your support of your child's participation in the problem solving program.

Parent's Signature: ____________________

APPENDIX C

CERTIFICATE OF ATTENDANCE

THE MATH SOLUTION (K-8) WORKSHOP

MARILYN BURNS EDUCATION ASSOCIATES

APPENDIX C

ATTENDANCE CERTIFICATE

Debra Hawver has attended

THE MATH SOLUTION (K-8)

Teaching Mathematics through Problem Solving

A 5-Day Course

8-18-89
Date

Marilyn Burns
Marilyn Burns

APPENDIX D

RESULTS OF PRETEST ATTITUDE SURVEY

1 - Grade 5, Class A

2 - Grade 5, Class B

3 - Grade 7, Class C

APPENDIX D-1

Results of Pretest Attitude Survey Related to Problem Solving - September, 1989 - Grade 5 - Class A

Student Number	Question Numbers 1	2	3	4	5	6	7	8	9	10	Total
1	1	2	1	1	2	1	3	3	1	1	16
2	1	1	1	1	1	1	1	3	1	3	14
3	1	1	1	2	1	3	1	3	1	2	16
4	2	3	2	3	2	3	2	3	1	2	23
5	1	1	1	3	1	1	1	1	1	1	12
6	1	1	1	3	1	3	1	3	1	1	16
7	3	2	3	3	2	3	1	3	1	1	22
8	1	3	1	1	1	1	1	3	1	3	16
9	1	1	1	3	1	3	1	1	1	1	14
10	1	1	1	1	1	1	1	1	1	1	10
11	1	1	1	3	1	1	1	1	1	1	12
12	2	3	1	1	1	2	2	3	1	3	19
13	2	3	3	3	3	3	3	2	2	2	26
14	1	1	1	1	1	1	1	3	1	3	14
15	1	1	2	1	1	1	1	2	1	3	14
16	1	1	1	3	1	3	1	1	1	1	14
17	3	3	3	2	3	2	3	2	1	3	25
18	1	1	1	3	1	2	1	3	1	3	17

(appendix continues)

Student Number	1	2	3	4	5	6	7	8	9	10	Total
	Question Numbers										
19	1	1	1	3	1	3	1	1	1	3	16
20	2	1	2	2	1	3	2	3	2	3	21
21	1	3	3	3	3	3	2	3	1	3	25
22	2	3	2	2	3	3	3	2	2	1	23
23	1	1	3	2	3	3	2	2	1	1	19
24	3	3	3	3	3	3	3	3	3	3	30
25	2	3	3	3	2	3	2	3	1	3	25
26	1	1	2	1	1	2	1	3	1	3	16
27	2	3	3	2	3	2	3	3	1	3	25
28	3	3	3	3	3	2	3	3	2	2	27
29	1	1	1	3	1	3	1	3	1	1	16
30	2	3	1	1	2	1	2	3	1	1	17
31	1	1	1	3	1	3	1	3	1	1	16
32	1	1	1	2	1	1	1	1	1	2	12
33	1	3	2	3	2	3	2	2	2	2	22

APPENDIX D-2

Results of Pretest Attitude Survey Related to Problem Solving - September, 1989 - Grade 5 - Class B

Student Number	Question Numbers 1	2	3	4	5	6	7	8	9	10	Total
1	2	2	3	1	2	1	1	3	1	3	19
2	1	3	2	2	2	2	3	2	1	1	19
3	1	2	1	1	2	2	1	2	1	1	14
4	2	3	3	2	3	3	3	1	3	1	24
5	1	2	2	2	1	2	3	3	1	2	19
6	1	1	1	3	1	2	1	3	1	3	17
7	1	3	3	2	3	3	2	3	2	2	24
8	2	1	2	3	2	1	2	3	1	3	20
9	1	2	2	2	2	1	1	2	1	1	15
10	1	2	1	2	2	2	1	3	1	3	18
11	1	2	1	2	1	2	1	3	1	3	17
12	1	2	1	2	3	2	1	3	1	3	19
13	1	2	1	2	1	2	1	3	1	2	[illegible]
14	1	2	1	2	1	2	2	3	1	2	17
15	3	2	3	2	2	1	1	1	2	3	20
16	1	2	1	1	2	2	1	3	1	3	17
17	1	2	3	2	1	2	1	1	1	3	17
18	2	2	2	3	2	3	1	3	3	3	24
19	1	1	1	3	1	1	3	1	1	1	14

APPENDIX D-3

Results of Pretest Attitude Survey Related to Problem Solving - September, 1989 - Grade 7 - Class C

Student Number	1	2	3	4	5	6	7	8	9	10	Total
1	1	3	2	2	2	2	2	3	1	2	20
2	1	3	2	3	3	3	3	3	1	2	24
3	1	2	3	1	2	2	2	3	1	3	20
4	1	2	2	2	3	2	2	3	1	3	21
5	1	2	3	3	2	3	2	3	1	2	22
6	2	2	3	2	2	2	2	3	1	1	20
7	1	2	1	3	2	2	2	2	1	1	17
8	2	3	2	3	3	3	3	3	1	1	24
9	1	3	2	3	2	1	2	3	2	1	20
10	2	1	2	2	2	3	2	3	1	3	21
11	1	2	3	2	3	2	3	2	2	2	22
12	1	2	2	2	2	3	1	3	1	3	20
13	2	2	2	2	1	3	1	3	1	3	20
14	2	2	1	2	1	2	1	3	1	1	16
15	2	2	1	2	1	3	2	3	1	1	18
16	1	2	2	2	2	2	3	2	1	1	18
17	1	2	1	3	2	2	1	3	2	3	20
18	1	3	3	3	2	3	2	3	1	1	22

(appendix continues)

Student Number	1	2	3	4	5	6	7	8	9	10	Total
				Question Numbers							
19	2	3	3	3	2	3	2	2	2	2	24
20	1	2	3	2	2	3	2	3	3	1	22
21	2	2	2	3	3	3	3	2	3	3	26
22	2	3	2	3	2	3	3	3	1	1	23

APPENDIX E

RESULTS OF POSTTEST ATTITUDE SURVEY

1 - Grade 5, Class A

2 - Grade 5, Class B

3 - Grade 7, Class C

APPENDIX E-1

Results of Posttest Attitude Survey Related to Problem Solving - April, 1990 - Grade 5 - Class A

Student Number	Question Numbers 1	2	3	4	5	6	7	8	9	10	Total
1	1	3	2	3	3	3	2	3	2	2	24
2	2	2	2	2	2	2	2	3	2	2	21
3	1	1	1	1	1	1	1	2	1	1	11
4	2	3	3	3	3	3	2	3	1	2	25
5	1	2	1	3	2	3	2	3	2	1	21
6	2	3	2	3	2	2	1	3	1	3	22
7	1	3	1	3	3	3	1	3	1	2	21
8	-	-	-	-	-	-	-	-	-	-	-
9	2	3	3	2	3	3	3	3	3	3	28
10	1	2	1	2	2	2	2	3	1	1	17
11	1	1	1	1	1	1	1	1	3	1	12
12	1	3	2	2	2	3	2	3	1	2	21
13	2	3	2	2	3	2	2	3	2	2	23
14	1	2	2	2	2	2	2	3	2	2	20
15	2	3	2	2	2	2	3	2	3	1	22
16	2	3	1	3	1	3	1	2	1	2	19
17	2	2	2	2	3	2	1	3	3	3	23
18	2	2	3	3	2	3	3	3	2	3	26

(appendix continues)

Student Number	Question Numbers 1	2	3	4	5	6	7	8	9	10	Total
19	2	3	2	3	3	3	2	3	1	2	22
20	1	2	3	2	1	2	2	3	2	3	21
21	2	3	2	3	2	3	2	3	2	3	25
22	-	-	-	-	-	-	-	-	-	-	-
23	1	2	2	2	2	1	1	2	1	1	15
24	3	3	3	3	3	3	3	3	3	3	30
25	2	2	2	2	2	2	1	3	2	2	20
26	2	2	1	3	2	2	1	3	1	3	20
27	1	3	3	2	3	2	3	2	2	1	20
28	2	2	2	3	3	2	3	3	3	3	26
29	2	3	3	3	2	3	2	3	3	2	26
30	2	3	3	2	3	2	3	2	3	2	25
31	-	-	-	-	-	-	-	-	-	-	-
32	1	2	2	2	2	2	2	3	1	1	18
33	1	3	2	3	2	2	2	3	1	1	20

- = Excluded from the program

APPENDIX E-2

Results of Posttest Attitude Survey Related to Problem Solving - April, 1990 - Grade 5 - Class B

Student Number	Question Numbers 1	2	3	4	5	6	7	8	9	10	Total
1	2	3	2	3	2	2	3	3	3	1	24
2	2	1	1	2	2	1	2	2	1	1	15
3	1	2	3	2	2	2	2	3	1	3	21
4	3	3	3	3	3	3	3	3	3	3	30
5	2	1	2	3	2	3	2	3	2	2	22
6	1	2	3	2	2	2	2	3	1	3	21
7	2	2	3	2	3	2	2	3	2	1	22
8	2	2	3	3	2	3	2	3	1	3	24
9	-	-	-	-	-	-	-	-	-	-	-
10	2	2	3	2	2	3	3	3	1	1	22
11	2	2	3	2	2	3	2	3	1	1	21
12	1	2	3	3	2	2	1	3	1	1	19
13	1	2	2	1	3	2	1	2	3	3	20
14	1	2	2	3	2	3	3	3	1	1	21
15	2	3	2	3	2	3	1	3	2	1	22
16	1	2	1	3	2	2	1	3	1	2	18
17	2	1	2	3	2	2	2	3	1	3	21
18	2	3	2	3	2	2	3	2	2	3	24

(appendix continues)

Student Number	1	2	3	4	5	6	7	8	9	10	Total
	Question Numbers										
19	2	3	3	2	3	2	2	3	3	2	25

- = Excluded from the program

APPENDIX E-3

Results of Posttest Attitude Survey Related to Problem Solving - April, 1990 - Grade 7 - Class C

Student Number	1	2	3	4	5	6	7	8	9	10	Total
1	1	3	2	3	3	3	2	2	2	3	24
2	1	3	3	3	3	3	3	3	1	2	25
3	1	3	2	2	3	2	2	2	2	2	21
4	1	2	2	3	2	2	3	3	2	3	23
5	1	3	2	3	2	3	2	3	2	3	24
6	2	2	2	3	2	3	2	3	2	3	24
7	1	3	3	2	2	2	2	2	3	2	22
8	2	3	3	3	2	2	3	3	3	2	26
9	1	3	2	3	3	2	2	3	3	3	25
10	3	3	2	3	2	3	2	3	1	3	25
11	2	3	3	2	3	2	3	3	3	2	26
12	2	2	2	2	2	3	2	3	1	1	20
13	2	2	3	3	3	3	2	3	1	3	25
14	2	3	3	2	3	3	3	3	3	2	27
15	2	3	3	3	2	3	2	3	1	1	23
16	2	2	3	2	3	3	3	2	2	1	23
17	2	2	2	2	2	2	2	2	2	2	20
18	1	2	2	3	3	3	3	3	2	1	23

(appendix continues)

Student Number	Question Numbers 1	2	3	4	5	6	7	8	9	10	Total
19	2	2	2	2	2	2	2	2	1	1	18
20	2	3	3	2	2	3	2	3	3	2	25
21	2	3	3	3	3	2	3	3	2	2	26
22	2	3	2	2	2	2	2	2	1	1	19

ABSTRACT

Improving Mathematical Problem Solving Skills of Fifth and Seventh Grade Students Through a Structured Problem Solving Program. Hawver, Deborah A., 1990: Practicum Report, Nova University, Ed.D. Program in Early and Middle Childhood. Descriptors: Mathematics/Problem Solving/ Teaching Methods/ Word Problems (Mathematics)/ Elementary School Mathematics/ Grades 5 and 7/ Cooperative Learning Groups/Strategies/ Attitudes/ Calculators/Logical Thinking

This practicum addressed the need to organize a structured problem solving program for fifth and seventh grade level students. The primary goal was to improve the students' problem solving skills. A secondary aim was proposed to enhance students' attitudes toward problem solving in mathematics.

The solution implemented consisted of a structured problem solving program. The 8-month program provided 20 minute problem solving sessions 3 days a week, Monday, Wednesday, and Friday. The instructional approach involved the students in a variety of guided activities, as well as independent and cooperative group learning. Students were exposed to various strategy techniques and offered opportunities for application of the different strategies. The use of calculators served to enhance students' problem solving skills and create enthusiasm. A pleasant atmosphere encouraged positive attitudes.

The results of this practicum were positive. Data indicated improvements were gained by students participating in the structured mathematics program. A total of 70 students were involved in the program. It was determined that 10 students increased their pretest percentage score by 20%. Also, 42 students showed an improvement. In addition, 15 students displayed a Normal Curve Equivalent (NCE) gain of 10 points as described, whereas 41 students demonstrated some degree of improvement. The overall results produced an NCE gain of 1.8. A total of 47 students, with 4 scoring 10 points or more, revealed an improvement toward their attitude concerning problem solving. A structured mathematics program can improve problem solving skills.

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Appendix 16

END

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Date Filmed

March 29, 1991